THE STORY OF PLANT LIFE IN THE BRITISH ISLES

TYPES OF THE NATURAL ORDERS

WITH AN INTRODUCTION, EMBODYING GENERAL BOTANICAL PRINCIPLES

VOLUME II

BY

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WITH 71 ILLUSTRATIONS FROM PHOTOGRAPHS AND SEVEN DIAGRAMS

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FRONTISPIECE.

IN THE HAUNT OF THE MEADOW SAXIFRAGE (*Saxifraga granulata*).
Daisies in the foreground.

Messrs. Flatters and Garnett. *See page* 213.

PREFACE.

IN an Introductory Volume to this series, thirty of the common natural orders and sixty-two of the better-known British flowering plants were described.

In this volume the orders mentioned (*supra*) are summarised, in some cases additional types are given, and a type (or more than one) of each order not there included is dealt with in its proper place. The introduction deals with some of the features of plant life that are of special interest, as—the cells, etc., and their work; the plant in its relation to soil, water, air, light, heat, nutrition and growth, absorption, transpiration, respiration, assimilation; the food requirements of plants. This is part of a summary of the general characteristics and principles of plant life, and the remainder is reserved for Vol. III, which also contains descriptions of the remaining natural orders. Thus the three volumes contain descriptions of types of every natural order. The work should be of assistance to school-teachers, as well as to their pupils, and especially to the botanist who is a beginner, and, I think, it may also appeal to the more advanced student.

The kindly reception accorded to the introductory

volume, both by the press and by individuals, makes me venture to hope that the object of the series is understood by that increasing body of the public which sees in Nature a something to love; something that not merely interests, but supplies an object for study and even research. The number of those so interested is not confined to one section of the public, but includes all sections; and, in these days of great educational facilities, a knowledge of such subjects as botany and zoology is within the scope of the poorest as of the richest. As a sign of the times, one meets continually gardeners who wish to study botanical principles. And, in course of travel, one notices even the business magnate, with a handbook on trees, scanning the country *en route* as an exercise in identification of the wild flowers passed within his range of vision. In a word, Nature Study, in all its phases, is a part of everyone's education to-day.

The endeavour to make these volumes, which describe types of the natural orders, introductory to other aspects of plant life, which I have had especially in mind in writing them, has also been, it would seem, successful. It may be possible to add to this systematic series additional volumes, dealing in greater detail with some of the features summarised in the introduction to each volume. There is a fund of interest in the plant life of the British

Isles which is almost incapable of being exhausted, providing fresh material to every one who studies it in an enlightened manner.

The author wishes to encourage, as stated in the introductory volume, the study of the life-history of plants, of which individually we know so little as yet, even of a very few species. The lines he has adopted may, he hopes, tend towards this desired end. Further, he would wish to emphasise the value of outdoor work—to be supplemented, of course, by indoor study. And it may be possible in a succeeding volume to deal with plant communities, and not individuals, as here. This study, ecology, is essentially an outdoor and experimental study, and one which cannot fail to sustain interest.

In the following up of this work with more detailed studies there are a number of special manuals which may be consulted. A list of these will be found in the appendix to this and the other volumes. To these also I am indebted to some extent for the accounts in the introduction of different phases of plant life.

In addition to the purely botanical features of each description, I have added notes on the English names. For these, as should have been added in the appendix to Vol. I., I am indebted to the 'Dictionary of English Plant Names,' by J. Britten and R. Holland. Similarly, for details as to plant

folk-lore, I am indebted to 'Flowers and Flower Lore,' by the Rev. H. Friend. In each case observations or notes extending over many years have been added where they applied.

It is hoped that the notes upon the illustrations appended to each description may be of help in studying the characteristics of each type; but I would advise the beginner or student to obtain fresh material himself, or herself, in the field, and to study the plant in its surroundings, noting the influence of soil or other factors, and of associated types, in addition to dissecting and studying it at home.

The MSS. and proof-sheets have been very kindly read for me by Miss C. E. C. Measham, Science Mistress, Wyggeston School, Leicester, who has also suggested helpful improvements.

For the illustrations I am indebted to Messrs. C. A. Allen, H. A. Cox, J. H. Crabtree, F.R.P.S., the late G. B. Dixon, F.E.S., Messrs. Flatters and Garnett (who in particular have endeavoured to supply the exact material needed), the Rev. C. A. Hall, and Messrs. B. Hanley and W. E. Mayes, to the last of whom I am under especial obligation.

A glossary and other useful features will be found in Vol. III, to be published shortly.

A. R. HORWOOD.

LEICESTER MUSEUM;
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THE STORY OF PLANT LIFE
IN THE BRITISH ISLES

VOLUME II

INTRODUCTION

1. Divisions of the Subject.

THE facts of botany, like those of zoology, or other branches of science, are capable of reduction to an orderly arrangement, and it is well that this is so, for the rapid accumulation of new data day by day makes it incumbent upon both the specialist and the general student to limit his or her activities to some one section of the subject.

Treated generally, botany is part of the study of biology, geology, including palæontology, and zoology being the other branches. Biology means the study of living organisms, their form, structure, function, life-history, and evolution.

The study of the forms of plants is implied in the

term *morphology*, but this really does more than take into account their form, and comprises also their internal structure, the relation of one part to another, together with the change which is undergone as the plant develops or is modified in response to environment, etc. Anatomy and histology are branches of morphology.

Anatomy, a term more familiar to the zoologist, is concerned especially with the structure of plants, internal as well as external. It deals with the parts of the members of which morphology treats. Thus, cross-sections are the study of the anatomist. Comparative anatomy enables one to determine the relationship between different forms. *Cytology* deals with the study of the cell, *histology* with that of the tissues.

Physiology deals with the work done by the plant, its activities, and the interpretation or relation of form or structure to function. Physiology is essentially an experimental branch of botany, and inquires into the functions of nutrition, growth and movement.

Systematic Botany is the study of the characters of different plants, their classification and arrangement, based largely upon external form. An endeavour is made to ascertain by aid of it the relationship of one group to another, or their affinity. This is denoted by the study of *phylogeny*, which also seeks to ascertain the origin or derivation of one type from another.

Fossil botany or *palæobotany* deals with all the foregoing features in the past, the study of extinct plants. It assists the knowledge derived from a study of present-day forms and their distribution, that is to say *geographical botany*, in unravelling the mysteries of *evolution*, a study which takes us back to the origin of forms, and deals with heredity, variation, hybridism, natural selection, Mendelism, the study of mutations, and leads us ultimately to the germ-cell and the chromosomes, and their behaviour under mitosis or other modes of cell-division.

This last study, a branch of cytology, but just begun as it were, in conjunction with *embryology*, or the study of the plant in its earliest stages, appears to be at the moment the most promising field for research.

In the introductory volume some general facts were stated as to the habitats of plants, flowering seasons, the habits of plants, the mechanism of the flower, pollination, seed dispersal and classification. No more was attempted than a general sketch of the subject, but it is hoped that enough was said to arouse interest in those for whom the book was specially intended.

In these two volumes it is proposed to deal with some other features of plant-life in a similar manner, viz.:

*2. The cells, tissues, organs and their office, etc. Transporting and elaborating elements.

* 1. Divisions of the subject (*ante*).

3. Soil and the plant
Water ,, ,,
Air ,, ,,
Light ,, ,,
Heat ,, ,,
} The factors which regulate the activities of the plant.

4. Nutrition and growth.

5. Absorption.
6. Transpiration.
7. Respiration.
8. Assimilation.
} The processes of manufacture, transport, etc.

9. The food requirements of plants. The materials transported and elaborated.

10. Germination and growth. First activities of the new individual.

11. The movements of plants. Response to stimuli.

12. Reproduction. Special contrivances for race perpetuation.

13. The forms of plants. Adaptations to environment and function.

14. The structure of plants. Adaptations to function.

15. The natural history of plants.

16. Classification.

17. Evolution, etc.

18. Geographical distribution.

19. Plant-formations.

20. The origin of plant types.

N.B.—1–9 are treated in Vol. II; 10–20 in Vol. III.

The facts that are mentioned under each section designedly constitute but a brief summary of each portion of the subject; and as the sub-title of these volumes on the "Types of Natural Orders" does not allow of a fuller treatment, this is left for possible further additions to this series with other sub-titles, such as "Plants and their Work." For, though the main object of the present volumes is to stimulate the interest of the beginner by the readiest and most easy means, by the study of plants, type by type, to be found close at hand around one, it is hoped that the purely systematic work thus begun, as a basis, will lead on to that of the other branches of botany to which reference has above been made. For this reason it has been considered more expedient at this stage in these introductory notes, at the risk of giving many facts without over-much illustration or experiment, to dispense with the latter. This omission is made in the hope that work thus begun in the open air, by a gradual acquaintance with plants in their synthetic form as complete living specimens, studied in the field, may lead on to the closer study and analysis of their structure, and the meaning of their functions. Hence physiological and microscopic work has been reserved for, possibly, further studies in this series. The general title, 'The Story of Plant Life in the British Isles,' furthermore, naturally covers all the phenomena of plant-life to be encountered in these islands, and this popular mode of treatment of British Botany and

perhaps novel mode of progressive study will, I venture to hope, commend itself to my readers, as a means of gaining accessions to the rank of botanical students.

An ample glossary, moreover, will assist the reader unfamiliar with new terms, and thus aided he will, it is hoped, turn for further information to the works quoted as helpful in this study.

2. Protoplasm, the Cell, the Tissues, the Organs of Plants and their Work. The Elaborating and Transporting Agents of Food Materials, etc.

A plant consists of a number of cells and vessels. The idea of a cell was derived from that of cork, which has a structure like honeycomb, where a series of hexagonal cells is placed side by side, as in the erect, prismatic, columnar structure, known as the Giant's Causeway, in Ireland. But in a plant body the cells are not all parallel, and have various arrangements.

The cell has a wall of cellulose, etc., and within it is protoplasm, as in a human cell. Structurally the cell is the unit; physiologically the protoplasm within or the protoplasts are the basal units.

Each protoplast is made up of the cytoplasm or main substance with a differentiated structure, the nucleus, in the centre or at the side.

Within the nucleus are wrapped up the mysteries

of the germplasm and chromosomes, which are concerned with the heredity of the plant and its transmission. Around the cytoplasm is a membrane or ectoplasm limited by the cell-wall, with which it is confluent.

Various vacuoles occur in the protoplasm formed in the meshes of the network. These take part in the isolation of useless material, or excretion, and in nutrition.

This network is filled with cell-sap, containing water with nutrient salts in solution, food, etc. It is the protoplasts to a great extent that build up the compounds mentioned (*post*) from the nutrient salts that are carried to them in water from the roots, and from the carbon derived from the carbon dioxide of the air.

The ectoplasm serves to retain the substances in the water, but allows the water to be withdrawn by osmosis. The strength of the solutes regulates the latter. The ectoplasm also helps to build up the cell-wall.

The cytoplasm, in which the nucleus and plastids are contained, is filled with cell-sap, and the starch, proteids, etc., manufactured from the crude materials it receives by absorption and photo-synthesis. The cytoplasm assists, on division of the nucleus, in the removal of the chromosomes to the opposite extremity of the cell, preparatory to the formation of germ-cells. It also takes part in the elaboration of the carbohydrates, proteids, etc., and the formation of ferments or enzymes which serve to digest the reserve materials

required. The protoplasts also help in the work of respiration when by katabolism their substance is transformed into simpler materials.

The nucleus is usually spherical and central or right-handed, and consists of a nuclear membrane, nuclear reticulum, and nuclear sap, with nucleoli. The first is a membrane like the ectoplasm. The reticulum is akin to the cytoplasm. The nuclear sap is a fluid which affords food and water, and the nucleoli contain reserves for nuclear- and cell-division. The nucleus is the portion of the cell which transmits the hereditary characters, and has to do mainly with reproduction and more or less all cell division. If it is damaged the plant dies.

In the protoplast are small bodies called plastids, which are round or of various shapes. The colourless ones are leucoplasts. The green ones are chloroplasts, the yellow orange or red ones are chromoplasts. One type may develop into the other, but each performs a different function. The leucoplasts give rise to the other types and make the starch-grains out of the soluble carbohydrates. The chloroplasts secrete chlorophyll-green and chlorophyll-yellow, and by means of these pigments the sun's energy is utilised to turn the carbon dioxide in the atmosphere into carbon, which is elaborated later into starch within the cell-sap. By aid of the chromoplasts the red, orange and yellow colours of flowers and fruits are obtained. Blue and red colours are formed also by anthocyan.

Apart from these functions the cell, for growth and reproduction (*q. v.*), divides up and becomes differentiated. The work of absorption, osmosis, synthesis of compounds, respiration, enzyme formation, excretion referred to, are only part of the activities of the cell. It also exhibits contractility—the power of perceiving and responding to stimuli, *e.g.* in the arrangement of chlorophyll granules, owing to too intense light, along the cell-wall.

The cells together form a series of tissues which have a definite form and arrangement, and are marked off at different parts of the plant body, *e.g.* a stem, to serve different purposes.

At the growing point the tissue is a primordial meristem, undifferentiated, with all the cells alike. A section further down shows a ring of protoderm, and, within the ground meristem, strands of procambium. Around the exterior, at a still more advanced stage, is an epidermis, and the procambium has become differentiated into an outer phloem, an inner xylem making up the vascular bundle, with cambium and secondary tissue between. The ground meristem is elaborated into a primary cortex, pericycle of bast fibres, primary medullary rays, and medulla or pith in the centre.

These are elaborated still further in the formation of a thick woody stem, when the primary meristem becomes primary or secondary permanent tissue, with or without secondary growth.

The epidermis serves to protect the plant against

the loss of water, disease or injury, being often provided with a layer of cork. In the cuticle of leaves are the stomata for transpiration and entrance of carbon dioxide gas, and intercellular spaces for respiration, for carbon dioxide gas to enter, and for transpiration, etc. The epidermal cells are usually colourless. They are filled with water, which they serve to store up to retain the plant in a state of turgescence and to protect the chloroplasts.

The primary cortex consists of collenchyma externally, parenchyma, stone-cells, and endodermis or the starch-sheath. The collenchyma is to impart strength. The parenchyma sometimes contains chloroplasts which manufacture carbohydrates, and it also stores up some reserves, as well as conducts materials. The stone-cells or short sclerenchyma cells serve for protection and impart strength. The bast fibres also impart strength. The endodermis or starch-sheath contains much starch, and is graviperceptional. Intercellular spaces, found in the rest of the primary cortex, are absent in the starch-sheath.

Between the last and the phloem is the pericycle. This contains bast fibres in many cases, or strengthening tissues. The parenchyma of the pericycle contains chloroplasts, and this also conducts and stores up carbohydrates, etc.

In the primary vascular bundle the phloem comes outside. It is the great conducting agent of the food-materials from one part of the plant to the other, being as well developed in the leaves, etc., as

the stem. The sieve tubes promote the upward transport of the starch, proteids, etc. They are associated with companion cells. The sieve parenchyma cells transport the carbohydrates and store up proteids, transferred from the sieve tubes, and carry into the medullary rays this material, for retention or further transference to the xylem or wood for transport, or to the parenchyma for storage.

The wood consists of tracheal or water tubes, tracheids, xylem parenchyma, and wood fibres. The tracheal tubes, where thick, serve to strengthen, the thin tubes serving for the passage of water and nutrient solutes. They thus function as water-carriers from the roots to the leaves. The tracheids also serve as strengthening tissues and for conducting water. The xylem parenchyma stores up a reserve of water and food, and may also transfer water upward to the leaves. The wood fibres are designed to impart strength almost entirely, and are not so sappy as the phloem.

The parenchyma cells store up starch. The cambium, lying between the phloem and xylem external to the latter, occurs in Dicotyledons, and serves to increase the thickness of the vascular bundles by the formation of secondary xylem and phloem.

The medulla or pith, which is central, serves temporarily for the storing and conduction of water, and also sometimes of food materials.

The intermediate primary meristem between the

vascular bundles forms primary medullary rays, which carry water and nutrient solutes, not upward, but laterally, and also store them up.

By cambial activity similar types of secondary tissues are formed, which serve the same sort of function as in primary vascular bundles. Since it is the object of the foregoing summary merely to indicate the relative function of different tissues in relation to the transport or storage of water or food materials, or other functions, it is unnecessary to describe the details of secondary vascular bundles from the structural point of view.

Nor has it been considered necessary to attempt this in connection with the primary vascular bundles, as this must come into a special study of plant anatomy.

So far cells and tissues have been considered. They constitute the internal structure or body, if one may so call it, of the plant.

It is now necessary to briefly indicate the part played by the *organs* of the plant, or the different parts of which a plant is made up.

In a general sense these are the root, stem, leaves, flowers, fruit, and seeds.

The function of the root itself is to retain the hold of the plants upon the soil. This, in fact, is almost the whole function of the roots of some aquatic plants. For absorption takes place in their case at all parts of the plant that are submerged, and many aquatic plants float upon the surface,

and the rootlets or rhizoids serve merely, perhaps, as a means of keeping the plant properly poised Some floating types, moreover, are rootless.

Upon the root are root-hairs. These are all-important in the absorption of water from the soil, and it is through the cellulose non-cuticularised walls of these that the water passes.

This applies to annuals and trees. In the case of many perennials, whose aërial parts die down in winter, especially tuberous-rooted plants, the root itself stores up material, or this may be done by specialised stem structures, such as rhizomes, bulbs, corms, tubers, which are commonly confounded with roots. But these are enlarged underground stem-bases, and roots proper, with root-hairs, are also found attached to them.

Parasitical plants are rooted in or on other plants, and whilst possessing root-hairs, derive their water or nutrient solutions from their host. In the case of saprophytes which live on decaying organic matter, the already elaborated materials of the host (or mycelium) are transferred by the roots. Epiphytes live on trees attached to their host. Some roots are used for climbing, as in the Ivy, a sort of epiphyte. The mistletoe receives the ascending sap and so lives as a parasite, whilst being also green or yellow it manufactures its own carbohydrates, but only to a small extent.

The stem, as has been seen in the case of tissues, serves as a means of transport of water and nutrient

salts, and of their storage. Certain tissues, the corky tissues, serve as a waterproof covering, and for protection. The bast fibres, etc., serve as girders or strengthening supports. Climbing plants have, however, to rely upon the support of others. The thin epidermis itself is a means of protection, being often covered with hairs, spines, etc. It also serves to prevent the loss of water, and protects the internal cells from mechanical injury. Superficial glands serve to get rid of, or to store up, oils and resins, etc. The cells are not green, but bright red or coloured, to protect the cortex from too intense light. In the wood the long tubes usually contain no living protoplasm, but serve only for water conduction or storage. The same applies to the branches, which form parts of the same circulatory system for water and food-materials.

The leaves have essentially the same kinds of tissue as the stem, but their arrangement and structure is not the same. They contain bundle sheaths which transfer carbohydrates from the leaves to the stem. The leaves are thin, usually broad, and expose a greater surface, relatively to their volume, than other structures. They play, in fact, the important part of presenting the chloroplasts to the action of the light.

The mesophyll of the leaf consists of long vertical palisade cells above in which the chloroplasts mainly occur.

Below is the spongy parenchyma, in which are

large intercellular spaces which are not so numerous in the palisade cells, and, leading through them, vascular bundles. Around the vascular bundle is a border parenchyma for water conduction. In the epidermis below are stomata with guard cells on each side, closed at night, open in daytime.

The intercellular spaces in the palisade cells and spongy parenchyma communicate, and carbon dioxide entering by the stomata is thus freely dispersed. Light can enter the epidermis and is absorbed by the chloroplasts, and under its influence the carbon dioxide entering by the stomata is broken up or rendered available for the fixation of carbon for use by the plant, or the manufacture from carbon dioxide plus water of a carbohydrate having the chemical formula, $C_6H_{12}O_6$. In the process oxygen is given off. Water is present above and below the mesophyll, and is transferred by the border parenchyma from the veins to the other parts of the leaf. The veins carry the above products away from the palisade and spongy cells. The veins thus bring water and carry away the products formed.

Leaves also serve, as do stems, to transfer away the superabundant water, and this is done by the stomata and intercellular spaces.

This water escapes as vapour. Carbon dioxide is also given off by the stomata. Under respiration, as opposed to assimilation, oxygen is utilised by all cells, and carbon dioxide is given off, as in animals. The protection of the stomata from being clogged

is ensured by the provision of hairs and their occurrence on the underside of the leaf.

The flower is, as has been shown in the introductory volume, a means of providing for the reproduction of the plant by the most effective means. Elaborated from inconspicuous foliar and axial structures, the modern flower, with its accessory coloured perianth, serves to attract the visits of insects, being now provided with honey and pollen in the stamens, which are sufficient inducement to bees, etc., to wander from one flower to another. By this or other means, *e.g.* wind, or animals as birds, slugs, etc., the pollen produced by the male essential organs or stamens is transferred to the female essential organs or pistils with the receptive stigmas.

By degrees the nuclear elements and protoplasm in the sperm-cell carried by the pollen-tube fuse in the ovule, after passing down the micropyle into the ovule, with the cytoplasm and nucleus of the female or egg-cell.

The fruit, lastly, serves as the crowning act of the plant's endeavour to carry on the race. After pollination and effective fertilisation and division the embryo develops in the embryo-sac, and there is stored up in the seeds, as a rule, reserve material in the form of endosperm.

Such, in brief, is the history of the various plant structures and the organs to which they give rise, in relation, in particular, to the part they play in the economy of the individual.

3. The Factors which Regulate the Activities of the Plant.

(a) *Soil.*

Plants live in soil or water, or, rarely, on other plants. In either case they are subjected to the influence of air, light, and heat. It is by aid of the three last, and of water derived from the soil, or, in the case of aquatic plants, from the surrounding medium, that they make their main non-nitrogenous organic substances, which consist of carbohydrates. From the soil (or water), however, they obtain the bulk of the inorganic and some organic substances which are contained in nutrient solutions. These will be described in section 9 (*post*).

These constituents are derived from the oxidation in the last instance of the mineral or organic substances found in the rocks. Primarily the former are made accessible to plants for nutrition by the action of various physical forces upon them, collectively included in the term "weathering."

These are water, which acts by chemical means upon the rocks, *e.g.* when carbonic acid in gaseous form in water dissolves such substances as calcium carbonate in the state of chalk or limestone or oolite. Felspars are affected in the same way by the decomposition of the silicates of potash and lime by the action of rain-water. Granite thus becomes clay and sand in course of time.

In another way water wears down rocks and

carries the particles away, by sorting them out, elutriating them, and redepositing the fine particles of sand, etc., in a looser form ready for use by plants, as soil on which they can live, in place of hard rock surfaces upon which they cannot.

Frost, ice, glaciers, alternate heat and cold are similarly important agents in breaking up rock masses into soft and loose soils, as sands, or in closer form, as clays, etc.

Out of all these many different rock formations, of which fifty might be named, there are about six types, differing chemically and physically, clay or loam, affording aluminium; sand, yielding silicon; chalk, yielding calcium; marl, yielding aluminium and calcium; humus, yielding carbonic acid, phosphorus, etc.; and humous acids in the form of peat.

Not only do soils differ in chemical characters, but in regard to the water they contain—a most important feature.

Rainfall is one source of the soil water. Another is dew. The slope of a tract determines the drainage, and mountainous tracts have to depend largely upon continuous rain, dew, and mist, which they, moreover, help to precipitate. The water which lies deep in the soil or telluric water derived from below depends upon the character of the soil, its permeability, etc., and the available underground sources.

The water thus collected from the clouds or underground springs or reservoirs may not be available, however, to the plant. The water in mountainous

districts is frequently poor in mineral salts, or is charged with too great a percentage in the case of bogs and moors, where there is a superficial layer of peat, of humous acids. In this respect there may be "water, water everywhere, but not a drop to drink," or, in a word, physiological drought: that is to say, the root-hairs may become clogged with the superabundant solutes, and unable to absorb. Since transpiration must go on the plant must suffer. To prevent this such plants have to adapt themselves to meet this kind of drought, in the same way as when physical drought on dry soils occurs.

In the valleys and other areas where the water is rich in mineral salts in solution plants that require such a rich supply can flourish. Root-hairs require a small proportion of salts, 1 to 3 per cent., alkaline as a rule, and sour acid solutions are detrimental to all but bog and moor plants, and even to these in excess.

The soil, if clogged with water, prevents the access of oxygen to the roots, and this again is a cause of wilting.

The permeability of the soil determines the amount of water presen , or rather whether it is retained or not. Thus, a clay soil retains water and absorbs it, but a sandy soil is non-retentive. The structure of the soil, loose or fine, the size of the particles, the texture, and density regulate the amount of water present.

A soil consists of small or large particles which touch one another, at one or more points. There are spaces between, or pores, in which water or air circulate as in the intercellular spaces in plants. The water coats the particles as a film, and the air circulates between. The films can become extended and water may flow between the particles. There is a line where the water is more continuous—the water-table. The soil above contains only hygroscopic water which adheres to the films, and is not capable of withdrawal. Where the water forms a thicker film, and can be withdrawn, it is called capillary water, and this is the source of the water which plants absorb.

The porous passages in the soil give it a degree of capillarity so that water can circulate freely through these passages, and upon their size and mode of communication or accessibility depends the available supply to the plant. In close soils the passages are small and easily clogged ; in more open soils where the grains are coarse there is a freer communication. Water is drawn up from the water-table by capillary motion or suction, as in a sponge, and raised to the surface. But the more open soils have fewer passages and less water is retained. The capacity of the soil for water is limited by super-saturation when all the passages are filled up, or by its limitation alone to hygroscopic water.

The measure of the water capacity of a soil is the amount retained after the excess is drained off. Clay

retains 41 per cent. of its volume or three times as much as sand. Similarly, the permeability of clay is less than that of sand, the water taking far longer to drain off or to be absorbed. The power of soils to absorb water which collects at night as water vapour above the soil is variable for each soil, and this variation depends on the foregoing physical characteristics.

In relation to temperature soils vary in their power of retention of heat. This depends on colour, dark soils retaining heat more than light, and water content, dry soils being warmer than wet soils. The latter, *e. g.* clay soils, are usually cold, and therefore unproductive.

The need of aëration in the soil is an important factor, for the roots require, like all parts of the plants, to respire, and oxygen in the ground air must enter by the root-hairs, or the lenticels, or air-spaces.

The chemical properties of the soil are important, as has been seen. There are two cases especially in which soil is markedly important. Maritime plants live in a soil in which saline salts are present. This would be inimical to all other types of plants. In the case of calcareous soil with calcium carbonate certain plants are fond of calcium, and are calcicole, as chalk plants, whilst others are calcifuge or calciphobe, and cannot live on such soils. They, however, occur on sandy soils.

(*b*) *Water.*

Water is the factor which divides plants into land-plants and water-plants.[1] Over and above this it plays one of the most important parts in the vital activities of both classes of plants, enabling them to carry out the processes of absorption, transpiration, and in part of assimilation. Mineral salts are conveyed in solution to the plant by water. The cell-sap, in which the solutes are carried, once they have entered the root-hairs, is largely water. The proportion of water in a plant is large. This is necessary to maintain the plant in a state of turgescence. The water current ascends and the food with it. It is given off in transpiration as vapour, or in small drops by hydathodes, as where the air is humid in the tropics or wet bogs.

The soil water, its amount, availability, and its characteristics have been described under soil (*ante*). In the case of land-plants the dry soil types or xerophytes are most dependent on the adjustment between the soil and its water capacity.

In order that a proper balance may be established between the amount of water taken in and that given off, or used, by the plant, absorption and transpiration must be compensatory. In the case of xerophytes absorption may be diminished, if the soil is cold, for

[1] Plants are divisible into land plants, including Hygrophytes, in which case the conditions are moist, xerophytes, where they are dry, mesophytes, where they are intermediate, and aquatic, where the plant lives submerged, or floating on the water.

the process by which the root-hairs absorb water, or osmosis, is retarded by cold, as heat in general promotes activity in plant-life, increasing the energy of the plant, whilst cold reduces it. If also the soil is sour or acid and contains a large percentage of salts (3–5 per cent.) the same effect is brought about and absorption ceases. Thus, even if there is plenty of water, if the atmosphere be cold or the soil cold, or the soils sour or acid, the same effect is brought about as if the soil were dry.

This is physiological drought. If the soil contains little water, also, absorption is slow and physical drought occurs. This is to be noticed in deserts, steppes, rocky regions, sandy soils, chalk hills, sea coasts, bogs, etc.

When the rate of transpiration is too great the plant suffers as much as if it were unable to absorb water. In general this is due to the evaporation of water. Transpiration is rapid in a dry atmosphere and ceases when the air is saturated with water vapour. The amount of moisture that can be retained in the air is raised when the temperature is high. Thus a high temperature favours rapid transpiration.

Wind also has a similar drying effect. At high altitudes the air is rarefied and evaporation is rapid. Wide leaves transpire freely, narrow less, in relation to volume. Transpiration is accelerated by intense illumination, but evaporation is not.

In order to counteract such a state of instability,

xerophytes have become modified to meet the exigencies of the habitat. They are frequently stunted, or dwarf, and may adopt the rosette or the cushion habit. The leaves also are adapted to meet these conditions. The surface is reduced, the stomata are fewer. The leaves are often fleshy. Many are evergreen, to effect economy of materials. The surface is screened by hairs, scales, etc., to prevent drying of the surface. The cuticle is often leathery, or waxy, to prevent the accumulation of water outside, and loss of water. The air-spaces are not so numerous. The leaf is thicker and the cells are filled with mucilage in fleshy types. Corky and lignified tissues filled with air help to retain the water.

The leaf is often needle-like, overlapping, small, thick, heath-like, with the margin inrolled, juncoid, long, smooth, circular and inrolled. The leaves may be modified and the stalks may become phyllodes, or shoots may have the same function as leaves, as in switch-plants, or where the leaves are scales with cladodes as in Butcher's Broom, or where plants develop thorns and spines, *e. g.* gorse. The leaves of heaths are overlapping and turn their edges to the light.

In contrast to the modifications of xerophytes to meet a lack of water, are those of water-plants to meet a superabundance of water. Water-plants do not transpire. They obtain their air and light and their food from the water.

Aquatic plants have large air-spaces in order that

they may be thoroughly oxygenated by the aid of the air in the water. This is their chief difficulty, to obtain air. The oxygen liberated in carbon assimilation is therefore largely retained for respiration, and to render the plant buoyant, so that it may struggle to keep its place in the sun.

The cuticle is thin and water is absorbed at all points. There is no need for stomata or guard-cells. The air spaces are always open. The water-lilies and other floating-leaved plants have the stomata on the upper surface, whereas land plants have them below or above in some cases, or both.

The leaves are thin and the chloroplasts are in the epidermal cells, in order to reach the less accessible light more readily. There is no need for strengthening tissues, as the surrounding water gives support, so that vascular bundles are not highly developed, and xylem is not present in many cases, but phloem is general. Many are monocotyledons.

The roots are reduced and serve as organs of attachment, without root-hairs.

The submerged leaves are much divided to present a greater surface to the light, and to facilitate the absorption of carbonic acid gas and oxygen in the water, and to offer less resistance to the current. Current leaves are often developed in the floating types till the floating leaves are developed. Ribbon leaves are adapted to the current. Awl-shaped leaves are found in floating or riparial types.

The floating leaves are circular or nearly so, with

the margin upturned. A few are ribbon-like, floating on the surface. Many have two types of leaves, submerged and floating.

The aquatic plant can thus absorb freely, but cannot transpire. The water is allowed to escape into the air-spaces. This renders aëration difficult, especially where the water is not running and so continually filled with fresh air. In stagnant water the oxygen is used up in the process of oxidation or decomposition of rotting matter. The difficulty of obtaining light is due to the breaking or deflection of the rays by the surface, and it is soon absorbed and altered, the red and yellow rays becoming quickly absorbed. The submerged aquatics are thus shade plants with long internodes, etc.

Similar in kind, but not in degree, are the adaptations of hygrophiles and mesophytes to water supply. Plants that exhibit one set of characters in summer and others in winter are called tropophytes. They are evergreen when they exhibit adaptations to physiological drought in winter, through cold, and have the characters in summer, though they are useful only in winter. Deciduous types throw off their summer characteristics in winter and become xerophytic.

The air or atmosphere serves as the main element in which land plants live. Aquatic plants live in water, and so get their air indirectly, whereas land plants get it directly.

(*c*) *Air.*

The atmosphere or air contains four gases—oxygen, nitrogen, water vapour, and carbonic acid gas. The amount of the last is ·03–·04 per cent., by volume, but sufficient to enable plants to obtain their carbon from it, and when this is realised one is inclined to marvel at the extraordinary activity of the plant. The effect of solar energy upon all life, however, explains this. In air also there is a greater or lesser amount of water, in the form of water vapour. The carbonic acid gas in the atmosphere is obtained by the plant to carry out the process of assimilation. The carbon is turned into carbohydrates and the oxygen is given off. The processes of respiration and assimilation are compensatory in animals and plants. Plants respire, as do animals, taking in oxygen and giving off carbon dioxide, noticeable chiefly at night, whilst assimilation is only possible during the day. In respiration, energy is liberated as the starch, proteids, etc., are broken down into carbonic acid gas again.

Nitrogen in the air is not directly available to plants. They obtain it, however, from the soil, which derives it from the air in the first place.

This is an outline of some of the more striking chemical characteristics of the atmosphere or air.

Physically the air acts upon the plant through its force or motion in the form of wind. This, as has been seen, promotes evaporation. As a result the

temperature is lowered, heat being lost when evaporation takes place. Not only is the soil rendered drier, but the plant is exposed to a drying process. The stunting effect of the wind is seen on the seacoast or on hills.

The effect of wind may be seen on the opposite sides of a range of hills lying in or across the path of the prevalent south-west winds. On the south-west side the plants are exposed to the full force of the wind, and more or less xerophytic; on the north-east side the vegetation is more luxuriant as a rule. Rain is deposited on the east side of the hills, and whilst the sunny side is the south-west the plants are exposed to drying action and more sun than on the north-east, where the winds are drier.

(*d*) and (*e*) *Light and Heat.*

We get light and heat from the sun. Without the solar energy life would be to-day impossible, whatever may have been the conditions in the past, *e. g.* in the Carboniferous period, when the huge arborescent Horsetails, Club-mosses, etc., lived in an atmosphere charged with humidity and a far greater proportion presumably of carbonic acid gas than there is to-day. But such conditions have to do with the secular history of the earth with which we are not here concerned, and of which, moreover, little reliable information is available, save hypothetically.

Light, in reference to plant nutrition and growth, is of all factors the most essential. Without it photo-synthesis would be impossible. But all plants do not get their food in this way. For there are green plants, and others that do not possess chlorophyll, which imparts the green colour to plants. Some of these last are parasites, some are saprophytes, which derive their food from other green plants. But they equally need light for growth, though not for nutrition. Fungi will grow in the dark, but they are not so well developed, quantitatively at least, as when they grow in the open, exposed to light. In this respect all non-green plants are like animals which do not make food, but derive it from the plant world which alone utilises solar energy for the creation of food.

To plants light is energy. To the consciousness of man light is manifested in the undulations of the ether which it sets up. The rays of light are made up of seven primary colours—red, orange, yellow, green, blue, indigo, violet. There are dark rays beyond each end of a spectrum, dark heat rays at the red end, ultra-violet or actinic rays at the violet end. In the process of photo-synthesis it is the red and yellow rays that act upon, and are absorbed by, the chloroplasts in starch-formation.

Light intensity varies, being greater at the Equator than the Poles, where the light falls obliquely. It is greater at mid-day, least at sunrise and sunset. The seasons similarly influence light intensity, which

is less in spring, autumn and winter than in summer, and the duration of light is connected with the seasons.

In relation to light plants exhibit certain sleep movements. The leaves close up at night and assume a vertical position. This prevents loss of water by transpiration, since under a cooler atmosphere absorption is slower. Flowers also close up at night and in wet weather.

Light affects growth also. Plants grown in the dark have long internodes. Too intense light has the opposite effect, causing dwarfing as in arctic plants. The relative amount of light causes plants to exhibit different characteristics, and some plants are called sun-plants when the leaves are small and thick with chloroplasts in several layers of tissue, but not in the epidermal cells. In the shade plants the leaves are thin and large, and the chloroplasts are in the upper layers of cells.

Heat, in the same way as light, is one of the most important factors of plant life. The vital functions of nutrition and growth, absorption, transpiration, respiration, and assimilation depend on the maintenance of a sufficient degree of heat. A rise in temperature advances, a fall retards, the activities of the plant, and its growth as a result.

It is the solar heat that is meant here. This varies according to latitude. The tropics are the warmest zones, the Polar regions the coldest, the temperate regions intermediate in this respect. From this

reason we have zones of vegetation depending on climate, which is affected by heat (and moisture, etc). In a similar manner altitude affects heat. There is a fall in temperature as one ascends. The zones of vegetation on mountains in the tropics in this way are parallel with those encountered in passing from the tropics to the poles.

Plant life ceases near the zero or freezing-point on a centigrade thermometer. But plants differ specifically in the amount of heat or cold they can withstand. And this especially applies to the most important functions after those of nutrition and growth, namely flowering and seed production. The seed is provided against cold, and is the most resistant to this factor. The duration of plants reflects their adaptation to heat and cold, so we have annuals, biennials, perennials, deciduous or evergreen shrubs. The storing up of reserves in bulbs, etc., is a modification to resist winter cold.

Cold reduces absorption and causes physiological drought. Similarly heat causes physical drought, or also physiological drought, whilst it promotes the plant's activities.

4. Nutrition and Growth.

Plants derive their food from two sources, generally speaking, the air and the soil. Water-plants, as we have seen, however, derive their food entirely from the water, which serves for the two sources of food

of land-plants, the air being diffused in water and the nutrient salts in the water.

Oxygen in either case, necessary for respiration, is derived from air by land-plants, from water alone by water-plants—that is, entirely submerged aquatics in all the cases mentioned above. Aquatic plants that are partly submerged, partly aërial, are intermediate in these respects.

Nutrition depends on the formation of organic food or carbohydrates in the plant, by the process of assimilation, and of proteids, etc., derived by absorption of mineral salts in solution, and transformed into organic substances in the plant.

The water absorbed is necessary to the plant, and forms a large part of its substance as cell-sap, but cannot be considered as food, though necessary for the proper carrying out of the process of transpiration, for carbon assimilation, etc.

Very little free nitrogen is obtained from the air by plants, but it is secured indirectly by leguminous plants from the bacteroids in their root-nodules.

A young seedling is already supplied with reserve material in the endosperm with which the embryo is frequently provided. When the radicle and hypocotyl have elongated, and the seed leaves are exposed to the light and air, the various processes already mentioned, absorption, transpiration, respiration and assimilation commence, and the young plant is enabled to carry on the functions of nutrition.

As soon as certain conditions are realised, a suitable

degree of temperature, a requisite supply of oxygen and water, these modes of activity are started into action and the plant grows. Light and a supply of food are also necessary conditions. Growth depends on the activities of living cells, and at the growing point the cells must be in a condition to divide and multiply.

Owing to the existence of seasonal changes in temperature growth is not continuous, and is accelerated or started, after the quiescent stage of winter, in spring, when the above conditions first begin to be realised, *i. e.* those that undergo change such as heat and light.

A temperature which is most suitable for plant-growth is about 28° centigrade, though plants can grow below this, and above about 40° C. plant growth is not usually possible. The first temperature is the optimum or most suitable temperature, the second is the maximum, while there is also a low temperature or minimum below which growth is reduced or impossible. These values differ for every plant. Above a temperature of 56° C. plants usually die.

The amount of water largely regulates these points of temperature. Seeds can resist higher and lower temperatures than the plant itself.

The presence of water in a plant is necessary for growth, for the filling of the cell with cell-sap, otherwise the plant collapses, as partly happens in withering or wilting. The size of plants depends on the

amount of water present. On dry soils plants are small or dwarfed, on wet soils they are more luxuriant. Flowering and fruiting, however, go on independently of water, and are accelerated by drought.

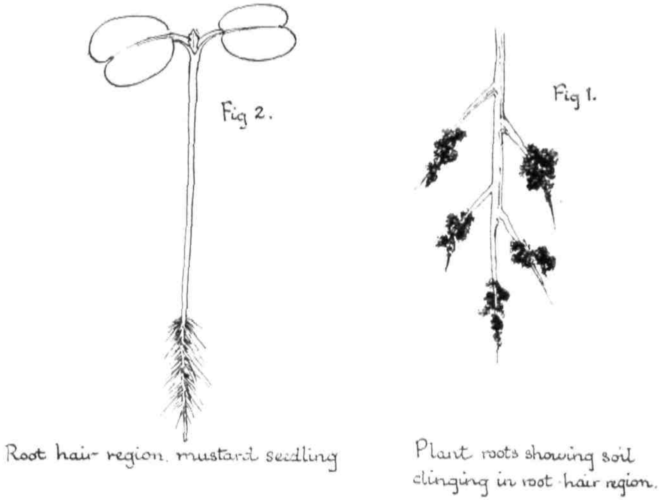
Unless there be oxygen the plant cannot respire, hence well-aërated soils and a clear atmosphere are the best conditions for growth. A smoky city atmosphere is deleterious.

The light conditions must be properly adjusted to the plant's requirements. Variation causes etiolation when plants grow in the dark or shade, and hence the division into sun plants and shade plants.

5. Absorption.

Reference has already been made to the fact that plants cannot take up substances from the soil except in solution. The mineral salts in the soil are either in the film of water around the particles which are adherent to the root-hairs (Fig. 1), or are in a solid state not soluble in water. In the latter case the root-hairs, which are outgrowths of the epidermal cells (Fig. 2), with vacuoles and a nucleus, dissolve such substances in an acid, which they excrete for the purpose. Marble or limestone is attacked in this way, and the effect of roots upon soil of a dark colour in which calcium occurs may be seen where it is bleached a light colour, by the action of such humous acids.

Where the root-hairs occur the epidermis is not



FIGS. 1, 2.—SEEDLINGS, SHOWING ROOT-HAIRS WHICH ENABLE PLANTS TO ABSORB WATER.

See page 34.

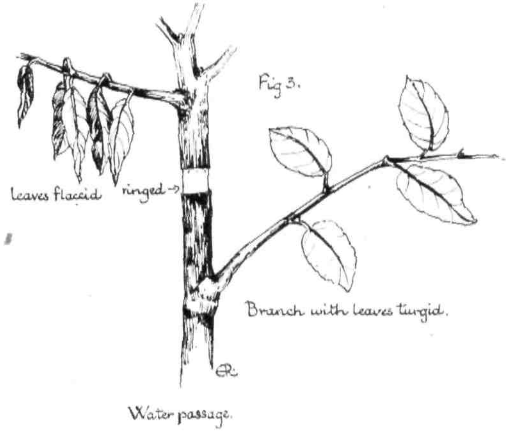


FIG. 3.—PLANT RINGED, SHOWING BELOW A LEAF NORMALLY TURGID; ABOVE, ONE DROOPING OWING TO LOSS OF WATER.

See page 37.

Emmeline Radford, del. *W. E. Mayes, photo.*

corky or made waterproof, but consists of cellulose, or is permeable to water, and mucilaginous. If soil adheres to a plant above ground or above the region of the root-hairs, it is easily shaken off, but in the latter region this is more difficult, and the water becomes slimy when a root has been vigorously shaken up in it. Various organic acids and carbonic acid gas are secreted by the root-hairs.

The number of the root-hairs gives the plant a great area of absorption, and if torn up a plant deprived of them at first withers, and does not completely recover till they grow again.

The protoplasts in the root are in the form of a film, and the cell-sap charged with organic substance in solution fills the rest of the cells. There is some power in this membrane which enables it to reject or select what substances in solution it needs from the soil.

The substances in solution enter the root-hairs through the epidermal cells, pass into the cortical cells, thence into the tracheids, and then ascend as cell-sap. The cells are arranged so that the sap already in part formed into food and the new cell-sap are not intermixed. There is, in other words, ascending sap and descending sap, which are set in motion by different means, travelling by different paths. The former, as water with mineral salts, etc., later travel by xylem strands upwards, the latter by the phloem downwards, as carbohydrates elaborated from the atmosphere by the chloroplasts.

The water and nutrient salts are enabled to enter by a special process, termed osmosis. By this means water can permeate a cellulose wall owing to its density being less than that of the solution on the inner side of the wall. By this means the cells become distended or filled, and are turgid. There is a continual passage of the water and nutrient salts inwards and a permanent state of turgescence within. This process is akin to diffusion, and in this special form is called osmosis. A similar process is recognised in the formation of crystals in the case of minerals.

The fluids tend to pass from a less dense condition to a denser by the affinity of the watery solution for the special conditions that are presented in the cells and tissues, where they undergo further elaboration. The dividing membranes play a part in increasing the concentration of the solution until it is sufficiently formative and capable of further elaboration.

External conditions assist the absorption of water and nutrient salts, such as temperature, absorption being rapid in a warm soil, slow in a cold soil. Above a certain degree (5 per cent.) solutions cannot, however, enter the plant, hence the reduction in osmosis in saline soil and in peat soil, where also the root-hairs are reduced in number.

Epiphytes get their water from rain and nutrient salts from whatever soil or humus accumulates in their aërial habitat. Desert plants also absorb water through hairs on the leaves.

6. Transpiration and the Ascent of the Sap.

When a tree has been felled especially in spring or summer the surface of the section of the trunk is seen not long afterwards to be covered with a watery solution, often sticky from the formation of sugar or starch. This is the cell-sap, which has been pumped upwards from below, and escapes where the tissues end. Such stems are said to bleed. A beetroot bleeds in the same way, the sap being in this case red.

The necessity for the cells to be filled with sap, and maintained in a state of turgescence, as seen above, correlated with the permeable character of the stretched cell-walls, naturally causes the water to rise. If a tree is ringed (Fig. 3), the leaves on the branches above the ring will become limp, owing to lack of turgor, or cutting off of the transpiration current; those below will remain turgid. There is, in fact, a pressure in the region of the root of the inflowing liquid upwards, and this root-pressure causes the ascent of the sap. Moreover, the liquid does not permeate all the cells, but entering at the borders is radially forced into the central long-celled vessels or the tracheal tubes and tracheids of the inner part of the stem. The outer cells and cortex serve to protect the plant from injury and loss of water. It is the young vessels that serve as water conductors.

The vessels in the tracheal tubes are thickened to prevent the extra pressure from rupturing them. Between these spiral and annular rings the vessels are open to feed the tissues laterally. These tubes are wide where produced near the growing points, and possess pitted vessels further back, where the conditions of growth are more fixed. The tracheal tubes ramify in the stem and pass out to the branches and leaves, and at every few internodes join up, like arteries. Thus all parts of the plant are fed simultaneously at any level.

The tracheids are closed cells with thin spaces or bordered pits through which a solution can find its way. They are less freely conducting than the tracheal tubes, which carry water upward, the tracheids dispersing it laterally but eventually upward or for short distances, but in some Gymnosperms only (or mainly) tracheids occur without tracheal tubes.

In travelling round a stem the water need not enter the medullary rays, as they are not continuous vertically, but, as some are for water-carriage, some for food-conduction, the pits enter the former, and so effect a radial, and at the same time a vertical, *circulation. In the rings of growth in a tree there is* sapwood and heartwood. The former carries water, and the latter is filled with food material, resin, etc. Some trees possess little sapwood. The wood of the year is the sapwood, and is most influential as a rule in conducting water.

The older tissues feed the newer and these last the leaves, having larger tracheal vessels. These tissues can be distinguished by putting a plant in red ink, when the water-conducting vessels become red.

The root pressure at the lower extremity of the plant is counterbalanced by the existence of another process, or transpiration. If it were not for this the plant would practically burst, filled to its utmost capacity with cell-sap.

But, by the joint processes of osmosis on the one hand, enabling the entrance of water and nutrient salts, and on the other of transpiration or the exit of water, there is a free circulation of water in the plant. The water passes out minus the nutrient salts, these being retained for the elaboration of proteids, etc., all the elements but carbon, and including hydrogen and oxygen, being obtained by absorption.

In the case of land-plants the water passes out through the stomata, which occur, as a rule, on the under-surface of the leaves. In water-plants transpiration is not possible. Water circulates through the intercellular spaces. In floating aquatics the stomata are above.

The stomata are openings with two guard-cells, one on each side, to close and open them. When the guard-cells are turgid the stomata open; when they are not, as at night, they are closed.

The vascular bundle, or main vein or midrib in a

leaf, gives off other veins, and these lead to the stomata through the mesophyll, and so the water is given off, as a rule, as vapour.

If some leaves have the stalks closed with plasticine and are placed under a dry bell-jar in a fairly warm room in the light, it will be found that the inside of the jar will, in a short time, be covered with drops of water. This water is formed by the condensation of the water-vapour given off by the leaves. The bell-jar prevents the removal of this vapour, and the air inside the jar soon becomes saturated so that water is deposited on the side of the jar (Fig. 4).

The water passes from the tracheal vessels into the spongy parenchyma and palisade tissue, and thence after exposure to heat, on evaporation, into the intercellular spaces, and so out by the stomata, but this can only happen at a proper temperature, as a rule during the day, for transpiration and assimilation go on simultaneously and the former assists the latter.

The palisade-cells appear to exercise the same sort of osmotic pressure above that the root-hairs do below upon the rising fluid. This water is required in the leaves, enabling the chloroplasts to decompose the carbon dioxide taken in by the leaves.

In some cases water itself is given off in drops by hydathodes or special cavities or exits for this purpose.

FIG. 4.—EXPERIMENT TO ILLUSTRATE THE TRANSPIRATION OF PLANTS.
See page 40.

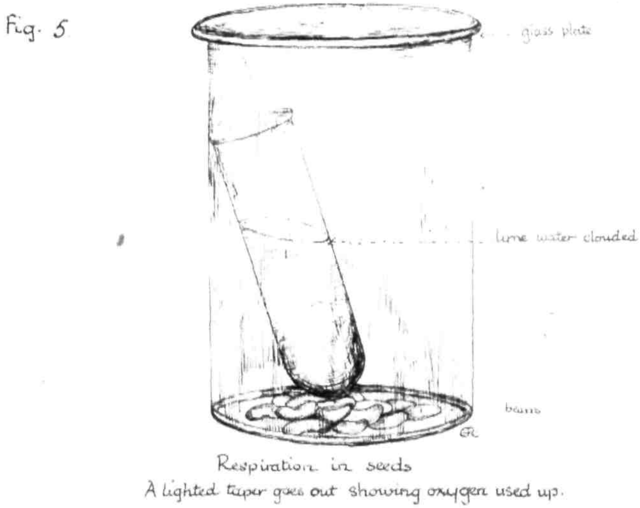


FIG. 5.—EXPERIMENT ILLUSTRATING RESPIRATION IN PLANTS. *See page* 43.

Emmeline Radford, del. *W. E. Mayes, photo.*

7. Respiration.

Like animals, plants need to respire, or to make use of the oxygen of the atmosphere, or water in the case of submerged aquatic plants, and ground air between particles of soil at the roots in the case of land-plants.

By means of respiration or oxidation the oxygen in the atmosphere is utilised and combines with carbon, so that carbon dioxide is set free and the oxygen is utilised or circulated. This is somewhat the reverse of the process of the carbon assimilation or deoxidation to be considered next. In the latter substance is gained, in the former gas is lost. In the former energy is locked up or potential, in the latter it is set free or converted into kinetic energy. The oxygen acts on the organic substances formed as food, and breaks them down by a process of katabolism in place of a building-up or anabolism. The work performed in the latter process must be translated into energy. In other words, the process or result of nutrition is of no use to the plant without a corresponding growth.

Every cell takes part in the process of respiration. This is facilitated by the existence of stomata, by which the air enters, and by the intercellular spaces into which such gases are passed, and then into the cells, where the gas is dissolved in the cell-sap, entering into combination with the carbohydrates.

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Loose layers of cells occur in the neighbourhood of the stomata, and these are found where corky tissue replaces the epidermis, and communicate with the intercellular spaces. Gases can pass in and out of these cells.

The lenticels play a great part in the entrance of air in respiration, both in the leaves and stem and roots. This explains how respiration can go on at night, for then the stomata are closed, as a rule, and air must enter the lenticels and carbon dioxide be given off. This is why it is unhealthy for plants to be placed in a bedroom. During the day oxygen is given off in carbon assimilation and carbon dioxide utilised, and the latter given off in respiration, which goes on at all times. This gas is used up in the plant at once in carbon assimilation. Little carbon assimilation is carried on through the lenticels, and transpiration also is not carried on through them to any extent.

Heat given off in respiration is more than used up in transpiration, and a plant cools quickly.

When air is devoid of oxygen plants use up the oxygen in the protoplasts and still give off carbon dioxide, but soon die. This is called intra-molecular respiration. The carbon dioxide given off during the day is diffused amongst the cells with chloroplasts and there directly synthetised. Where no chloroplasts occur there is no evolution of oxygen for respiration, but the carbon dioxide being given off by respiration flows to the cells capable of utilising

it. As there are none at night that can do this it is given off to the atmosphere. Hence, too, the oxygen required for respiration at night is obtained from outside and not from within.

Dry seeds do not respire because they are inactive, but as soon as they germinate carbon dioxide is given off and growth begins with the commencement of energy.

Some germinating seeds are placed at the bottom of a flask, which is corked, and has a small test-tube containing lime-water suspended from the cork. A second flask is arranged in the same way, but without the seeds. After about twenty-four hours the lime-water in the test-tube in the first flask will have clouded and a lighted taper held in the flask will go out. In the second flask the lime-water will show a very slight film on the top and a lighted taper will burn. The presence of the germinating seeds has increased the amount of carbon dioxide in the air and decreased the amount of oxygen. The same result is obtained both in the light and in the dark. It can also be carried out with roots and portions of stems. In the case of leaves the flasks must be kept in the dark, as in the light carbon assimilation is so active that the respiration is difficult to trace, and a more elaborate experiment is required to demonstrate it. Such experiments show that all parts of plants respire by day and by night (Figs. 5 and 5 *a*).

8. Carbon Assimilation and Photo-Synthesis.

There are green plants and others not green. It is found that those that are not green have to depend for their nutritive material on green plants. The green colour of such plants is due to the presence of chlorophyll, a pigment manufactured by the chloroplastids. Chlorophyll is a green or yellow substance contained in chlorophyll granules in the cells of the leaves in particular. When the light is intense these bodies arrange themselves in a certain direction. When the light is normal they expose as much surface as possible to the light. In such circumstances the sun is shining. The cells containing the chlorophyll granules are in direct communication with spaces or avenues which are connected with openings below on the under-surface of the leaves, generally speaking. From these openings it may be shown that oxygen is being given off, as in the case of the following simple experiment.

Some Canadian water-weed is placed in a vessel of water. A test-tube full of water is inverted in the vessel and supported by a retort stand so that the bottom of the test-tube is well above the bottom. This is to ensure a good supply of well-aërated water. The basal ends of the stems of the water-weed are then introduced under the test-tube and the apparatus is kept in a good light. Bubbles of gas will be seen to rise from the stems. The gas will rise to the top

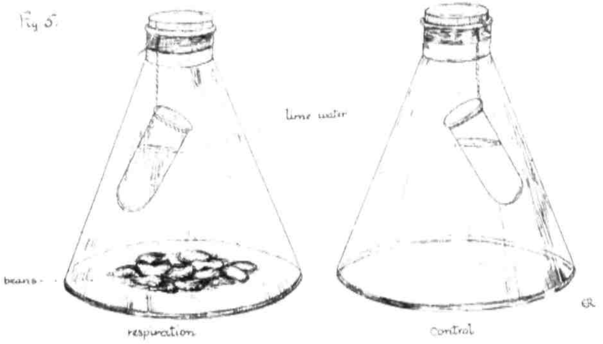

FIG. 5*a*.—EXPERIMENT ILLUSTRATING THE RESPIRATION OF PLANTS.
See page 44

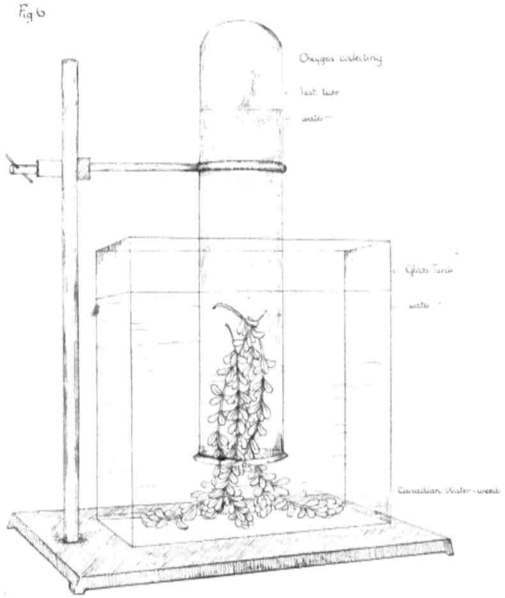

FIG. 6.—CARBON ASSIMILATION IN WATER PLANTS WITH EVOLUTION OF OXYGEN.

Emmeline Radford, del. *See page* 45. *W. E. Mayes, photo.*

of the test-tube and displace the water. Thus in time a test-tube of the gas may be collected. A glowing chip will ignite if held in the test-tube, showing that the gas collected is oxygen. In water deprived of air there is no bubbling, even in the best of light (Fig. 6).

What happens when the chloroplasts are exposed on one side to the light of the sun, which is a source of energy, and on the other to the water of transpiration, is that the carbon dioxide of the atmosphere taken in combines with the water, and the action of light upon the chlorophyll is that the latter takes up some energy by photo-synthesis, and the chloroplast, by a process called assimilation or fixation, builds up the carbon into starch or possibly cane-sugar, and the first product is formaldehyde, CH_2O, and then sugar. During the process oxygen is evolved.

Thus, $CO_2 + H_2O = CH_2O + O_2$.

It is then the chlorophyll which energises the chloroplast which is the prime factor in this function.

The starch grains occur in the chloroplastids, showing clearly that the latter are the originators of this organic compound.

If placed in formaldehyde the chlorophyll is extracted and the plastids remain.

Engelmann showed that the red rays are the most important in photo-synthesis and carbon fixation.

The green, blue, and violet rays are little, if at all, used. Certain bacteria will collect around a plant

placed in the light and disperse if light is withdrawn, showing oxygen is given off through assimilation only in the light. Seen through the spectroscope the bacteria collect mostly under the red light, less so under the orange and yellow rays.

The border parenchyma brings water from the veins to the palisade and spongy parenchyma, and food is transferred from them to the sieve tubes to travel down the leaf.

The intercellular spaces provide channels for the intake of gases. The epidermis lets light into the top layer of palisade cells where lie the chloroplasts, arranged along the walls vertically, with intercellular spaces between with carbon dioxide and water. Two per cent. of the light passing through the leaf is used in synthesis, the rest in the evaporating of the water into water vapour. The border parenchyma cells thus bring water and take back food from the palisade and spongy cells, and the phloem and veins carry it down to the stem and elsewhere.

In order that photo-synthesis and carbon fixation may occur there must be proper light, the stomata must open and admit carbon dioxide, the veins must bring the transpiration water from below. They must also carry down the food, as made or elaborated.

The formation of starch takes over an hour in some cases, five minutes in others.

The proportion of carbon dioxide in the atmosphere is very small—·03—but this is sufficient, under the

action of light, to form starch in the chloroplasts. A state of turgescence assists the production of starch. Light and temperature must be of a more or less standard character, assimilation being weak or ceasing in a poor light or at a low temperature.

The process of carbon assimilation after photosynthesis is one of the most important in the whole of the plant's activities. Upon its success depends also the possibility of animal life.

9. The Food Requirements of Plants. The Materials for Transportation, Elaboration, etc.

If a plant be burnt there will be found on examination of the ash that remains behind after combustion some thirteen chemical elements. These are—carbon, hydrogen, oxygen, nitrogen, sulphur, phosphorus, potassium, calcium, magnesium, iron, sodium, chlorine, silicon.

Some of these are, moreover, found in the substances built up by the plant, such as starch, into which carbon, hydrogen, and oxygen enter, as represented by the chemical formula $C_6H_{10}O_5$. In the proteids also are found nitrogen and sulphur. Phosphorus is found in the nucleus, and was at one time regarded as the physical basis of life.

An experiment which proves that these elements, or some of them, are essential to plant life is the growing or culture of plants or seeds in a solution.

At the outset it should be stated that plants cannot utilise solid food, but only matter in solution. Secondly, it should be remarked that plants do not obtain their nutriment from the elements themselves, but from compounds or salts that are found in the soil water. This acts upon the organic and inorganic substances in the soil, and prepares them for use by the plant by a process of decomposition.

The salts used in 1000 c.c. of distilled water may be potassium nitrate, 1 grm.; sodium chloride, ½ grm.; calcium sulphate, ½ grm.; magnesium sulphate, ½ grm.; calcium phosphate, ½ grm.; and a trace of iron chloride.

It was the German botanist, Sachs, who first invented this method of showing the requirements of plants. Grown thus as a water-culture, a seed will germinate and put forth roots, leaves, flowers, and even fruit.

If the plant be chemically analysed it will be found to contain half its weight of carbon after the water it contains has been evaporated. The carbon was not supplied in the solution, and has therefore been derived from the air by the leaves and not from the roots.

Of the six compounds added to the water it can be found that all but sodium chloride are essential to the plant, for if one is left out or another substituted the plant suffers, so that the six elements, Potassium, Nitrogen, Calcium, Magnesium,

Phosphorus, and Iron are necessary to the growth of a plant, with also the carbon, hydrogen and oxygen obtained from the carbon dioxide of the atmosphere and water. Sulphur is also an important element. If iron is omitted there is no formation of chlorophyll, and without the latter no photosynthesis of carbon.

The table given below, compiled by Warington, shows the relative proportion of the substances found in the ash of different parts of plants.

	Weight of crop.		Total pure ash.	Nitrogen.	Sulphur.	Potash.
	At harvest.	Dry.				
Wheat (grain) 30 bushels	1800	1530	30	34	2·7	9·3
Wheat (straw)	3158	2653	146	16	5·1	19·5
Beans (grain), 30 bushels	1920	1613	58	78	4·4	74·3
Beans (straw)	2240	1848	99	29	4·9	42·8
Potatoes (tubers) 6 tons	13440	3360	127	46	2·7	76·5

	Soda.	Lime.	Magnesia.	Phosphoric acid.	Chlorine.	Silica.
Wheat (grain) 30 bushels	0·6	1·0	3·6	14·2	0·1	0·6
Wheat (straw)	2·0	8·2	3·5	6·9	2·4	96·3
Beans (grain) 30 bushels	0·6	2·9	4·2	22·8	1·1	0·4
Beans (straw)	1·7	26	35·7	6·3	4·3	6·9
Potatoes (tubers), 6 tons	3·8	3·4	6·3	21·5	4·4	2·6

If single salts are employed they may have a toxic or harmful effect. But the mixture of several salts is

beneficial, if not essential, as above. Calcium added to any other salt reduces the toxic effect.

For the supply of nitrogen nitrates are the best source for plants and can be artificially added. Plants cannot themselves fix the free nitrogen in the atmosphere, of which this gas and oxygen are the main constituents. But certain bacteria are able to do so. It is also obtained from ammonia. Some plants require nitrates, some ammonium salts, but the former are generally more beneficial. The addition of nitrogen may not only increase the concentration of nitrogenous food in the soil, but also the amount of root or absorbing surface, or number of root-hairs, and of the leaf or assimilating surface, as pointed out by Russell, and so cause the whole plant to increase in bulk by accession of carbon, etc. The amount of water, temperature, etc., may affect the increase in growth which otherwise would result from the supplying of nitrogen.

Phosphorus is supplied as phosphates to plants and promotes root development, being most useful on clay soils. Phosphates are unnecessary for sandy soils, in which plants usually develop abundant roots or rootlets. In dry regions they cause the young roots to seek the moister layers. They tend to accelerate the ripening of the fruit or seed. Absence of phosphates, however, is not so detrimental as absence of nitrates, at any rate in so far as cereals are concerned. For mitotic cell-division phosphoric acid seems to be an essential, mitosis not taking place in its absence.

Potassium is essential to the formation of starch, for photo-synthesis, or the transfer of carbohydrates to the different parts of the plant, cannot take place without it, and there is a cessation of sugar- and starch-formation. The absence of potassium compounds in the soil or nutrient salts also tends to produce undersized fruits or seeds. In drought or other abnormal seasons plants flag or wilt more readily where there is a deficiency of potassium, and they are less able to resist the attacks of parasitic fungi, rusts, etc.

To some extent a deficiency of potassium may be repaired by the supply of sodium.

Calcium is beneficial in leaf and seed production. It may counteract the effect of saline salts. The root system is impoverished when there is a deficiency of calcium compounds in the soil. Calcium, like potassium, is chiefly found in the leaf.

Magnesium is useful in seed production. Chlorophyll is, according to Willstatter, a compound of magnesium. Magnesium is also instrumental in the formation of oil in seeds, etc.

Iron, as has been mentioned, is essential to chlorophyll formation, and without a trace of ferric salts it is not formed. A trace of manganese is found in some plants.

Chlorine is not essential to plant growth, but is generally present in the form of chlorides in rain-water. Similarly, iodides and fluorides are beneficial.

nected. The requisite temperature at which each plant thrives differs according to species. With an increase in temperature growth is promoted. But if it is too high plants become lank or too tall and do not grow laterally. The seedling requires a lower temperature than the growing plant, and either than a plant in the fruiting stage.

Water, especially in the case of terrestrial plants, is of vital importance. There is a medium of supply below or above which plants do not flourish. The salts in solution must also be of the right kind, and neither in excess nor the reverse. With excess of water there is a reduction of available oxygen. With too little the plant cannot be maintained in a state of turgescence or distension.

If the nutrient salts in solution are very concentrated, the loss by evaporation in the cell-sap is reduced. If the food is increased water is economised. The necessary water of transpiration must frequently exceed the amount available by absorption.

When water is not abundant the output of leaves is less and transpiration is not so rapid. Excess of water tends to vegetative growth, whilst the reverse or drought induces the hastening forward of flowering and seeding.

The organic substances of which the plant is composed contain compounds derived from the foregoing elements. They are either non-nitrogenous, or nitrogenous. To make the account of the processes by which these substances are built up in the

plant more easy to comprehend they are described here.

Of the non-nitrogenous substances the principal are the carbohydrates, which are made up of carbon, hydrogen, and oxygen. They include, in the first place, sugars, which are usually dissolved in the cell-sap. Of these the chief are glucose, dextrose, or grape sugar, found in fruits such as the apple, which contains up to 10 per cent. of these sugars.

Fructose, fruit sugars, or levulose, also occur in fruits, as the first two names indicate. Cane-sugar or saccharose is found in stems and roots in the cell-sap—in beet for example. This is the source of the sugar now being derived from the beet industry in this country. Maltose is another type found in grain. An enzyme is the origin of fermentation in yeast. Starch is found in the form of starch grains, in such tubers as those of the potato. It occurs also in roots and in grain or seeds generally. The grains differ in form and size in different plants. Starch occurs in two forms—granulose and farinose.

Cellulose forms the basis of the cell-wall of plant structures. Its occurrence in plants was at one time considered to be a distinction between animals and plants, but it occurs also in animals. There are different kinds of cellulose. Cellulose is found also in lignified tissues. The celluloses are combined with other compound celluloses, such as pectocelluloses, found in carrots, etc., adipocelluloses, found in corky tissue as suberin, and in the cuticle as cutin,

lignocelluloses found in woody tissues. Inulin is of the same composition as starch, and found in many of the Compositæ, as in the Dahlia and Chicory roots, Bellflower group, etc., in bulbs of Liliaceæ, etc.

In addition to carbohydrates there are fats and fixed oils, made up of compounds of glycerine and fatty acids with less oxygen than in the first group. They occur in the cell matter as drops, and in reserve materials, found largely in endosperm and the young seed leaves, and in fruits.

A third group consists of volatile or essential oils which are the basis of the perfumes of flowers, as in the rose. Some are made up of carbon and hydrogen, without oxygen, but in others the last is present. They occur in the same form as the fats and fixed oils, and may be developed in connection with glands or other accessory structures.

Many organic acids are found in plants, such as malic, oxalic, citric, tartaric acid, etc., and are either free or combined. A common example is Sorrel, in which binoxalate of potash occurs. Crystals of calcium oxalate also occur, as single crystals, in needle-like bundles or raphides, etc.

The nitrogenous organic substances include those that are built up of carbon, hydrogen and oxygen, and also of nitrogen, with sulphur, and phosphorus.

The proteids or albuminoids are slimy and coagulate when warmed, and are found in connection with the protoplasm of the cell, being present in all parts of a plant. Some are employed as reserve materials as

aleurones, especially in seeds, and grain contains a large proportion in the outer layers of the endosperm, being large or small in different cases.

Amides are crystalline substances found in the cell-sap, *e.g.* asparagine found in the parenchyma.

Alkaloids are the compounds which form the basis of the poisonous and other principles which are used as drugs, *e.g.* nicotine.

[*The remainder of the Introduction will be found at the beginning of Vol. III.*]

CHAPTER I

DICOTYLEDONS (PLANTS WITH NET-VEINED LEAVES)

(*Introductory Volume, p. 32*)

FLOWERING plants are termed "Phanerogams," because they show an evident flower, as opposed to the Cryptogams, where the inflorescence, cone-like in some cases, consists of sporophylls and bracts, but no perianth differentiated as in Phanerogams.

Robert Brown further divided Phanerogams into Gymnosperms and Angiosperms. The former have the seeds or fertilised ovules not enclosed in an ovary or fruit-wall. In the Pine the ovules are protected by a persistent woody bract, but otherwise the ovules are naked.

In Angiosperms the ovule is enclosed in an ovary, the carpel being closed, and the pollen-tube pierces this in its passage towards the micropyle to affect fertilisation.

Thus, both Gymnosperms and Angiosperms may be grouped together in one class, Seed-plants or

Spermatophytes, and they are subdivided as above, according to the absence or presence of an investing ovary or fruit-wall.

Angiosperms, with which this book is concerned, differ further from the Gymnosperms in having no endosperm till after fertilisation, whereas Gymnosperms possess endosperm before fertilisation has taken place.

Angiosperms possess true flowers, of which the essential parts are the stamens and pistil. The stamens bear pollen-sacs, which are equivalent to the microsporangia of the Pteridophyta amongst Cryptogams, and the carpels bear ovules which are equivalent to the megasporangia.

The pollen resembles the microspores of Gymnosperms and Pteridophytes. The ovules are, however, as has been said, enclosed in carpels. There are two integuments (or one), and there is usually one embryo-sac in the nucellus, with one ovum at the micropylar or upper end, which is not, as in some Cryptogams, enclosed in an archegonium. The three antipodal cells occupy the other end, representing another egg-apparatus, in this case functionless. There is a large nucleus in the centre, which gives rise to the endosperm after fertilisation, and this fills the sac.

The Chalazogamæ differ somewhat from other Angiosperms in the mode of fertilisation.

Angiosperms are also divided into two groups, according to the character of the cotyledons.

In Monocotyledons there is but one cotyledon, and this is lateral or sheathes the plumule in Gramineæ. Ray first differentiated these two groups, which are distinguished further by other characters correlated with these main features, and thus form natural groups.

There are two cotyledons in Dicotyledons as a general rule, except in some Ranunculaceæ, and a few isolated types, whilst Sweet Gale (*Myrica Gale*) has more than two.

In Dicotyledons the embryo is provided with two cotyledons, and the plumule is central, the cotyledons lateral, the radicle opposite the plumule and below. The leaves are usually net-veined. The stem structure shows secondary thickening, and the wood consisting of ducts and fibres surrounds a central pith, the wood being further arranged in concentric rings, and a new layer is added each year to the outside. There are medullary rays radiating from the centre. The bark is increased by new layers on the inside. The flowers have the parts in whorls or a perianth of five, or four, or two members, rarely in threes.

The system of classification used in this country is that of Bentham and Hooker, based on those of De Candolle and Jussieu. As the arrangement of Engler, which takes into better account the anomalous Apetalæ, is being more generally used, a summary of it is given at the end of Volume III.

In the former system four groups of the class Dicotyledons are recognised, viz.:

Sub-class I: Polypetalæ.

Series I or Sub-division I: Thalamifloræ.

„ II „ II: Calycifloræ.

Sub-class II: Gamopetalæ (= Corollifloræ) (or Monopetalæ).

Sub-class III: Apetalæ (or Incompletæ or Achlamydeæ) (and Monochlamydeæ).

Bentham and Hooker also recognised a third series, *Discifloræ*, amongst Polypetalæ, which included, amongst British groups, the Flax group, Geranium group, Holly group, Spindle group, Maple group. In this group the sepals are distinct or united, free or parallel to the ovary, the disc usually conspicuous as a ring or cushion, or spread over the base of the calyx-tube, or confluent with the base of the ovary, or broken up into glands; stamens usually definite, inserted upon, or at the outer or inner base of, the disc; ovary superior.

POLYPETALÆ.

The Polypetalæ have the petals distinct, and the perianth is double in both of its sections, Thalamifloræ and Calycifloræ.

In Gamopetalæ, where the perianth is also double, the petals are, however, united, and the name Monopetalæ expresses this as well as does Corollifloræ.

In the Thalamifloræ the perianth is hypogynous and situated below the ovary. In the Calycifloræ

Tabular Classification of Plants.

Main Groups.

- Plant Kingdom.
  - Cryptogams.
    - Algæ.
    - Fungi.
    - Lichens.
    - Mosses.
    - Hepatics.
    - Horsetails.
    - Ferns and their allies.
  - Phanerogams.
    - Gymnosperms.
      - Conifers.
      - Cycads.
      - Ginkgo,
      - Gnetum, etc.
      - Welwitchsia, etc.
    - Angiosperms.
      - Monocotyledons.
        - Microspermæ.
        - Epigynæ.
        - Coronarieæ.
        - Nudifloræ.
        - Apocarpæ.
        - Glumaceæ.
      - Dicotyledons.
        - 1. Polypetalæ.
          - Thalamifloræ.
          - Calycifloræ.
          - Discifloræ.
        - 2. Monopetalæ or Gamopetalæ.
          - Corollifloræ.
        - 3. Apetalæ (or Monochlamydeæ or Incompletæ)

the perianth is perigynous or situated around the ovary, in which case the parts appear superior, whilst the ovary is still superior, or the stamens are epigynous, or upon the ovary, and the ovary is thus inferior. Exceptions occur, however, in each case.

In the Polypetalæ the flowers have both calyx and corolla, and are, therefore, dichlamydeous. The petals are free. This last feature, however, is present in some Monopetalæ, as in Ericaceæ, in *Pyrola* and *Monotropa*, and in Plumbaginaceæ. In Polypetalæ, also, the calyx or corolla is sometimes absent. In some Ranunculaceæ, in Meadow Rue, Wood Anemone and Marsh Marigold there are no petals, the sepals being petaloid. There are also in Cruciferæ exceptions, including plants with no calyx or corolla, in some species of *Cardamine*, Wart Cress, and Pepperwort, and some species of Violet are sometimes apetalous. In Caryophyllaceæ petals may be absent in *Arenaria*, *Cherleria*, and *Sagina*.

In Rosaceæ there are no petals in *Alchemilla* or in *Poterium*, nor amongst Saxifrages in *Chrysosplenium*. In Halorageæ the flowers are apetalous, and amongst Lythraceæ in *Peplis*, amongst Onagraceæ in *Ludwigia*.

THALAMIFLORÆ (FLOWERS ON A RECEPTACLE OR DISK).

The petals are usually distinct and separate in this group, or absent. The petals are in 1–2 or an

indefinite series. There is usually a calyx and corolla. The stamens are inserted on the receptacle and hypogynous, being below and free from the ovary and calyx, or on a short or long stem or upon a disc at the extremity of the flower-stalk. The ovary is superior; the stamens are, therefore, inferior.

In this group are included some forms in which the stamens are apparently perigynous or epigynous, as in *Nymphæa*, and in some Caryophyllaceæ.

The ovary is apocarpous with one or more carpels, with the ovules sutural or basal in Ranunculaceæ and Berberidaceæ.

The ovary is syncarpous, 1- or more celled, in Nymphæaceæ, Papaveraceæ, Fumariaceæ, Cruciferæ, Resedaceæ, Cistaceæ, Violaceæ, Caryophyllaceæ, Portulaceæ, Tamaricaceæ, Polygalaceæ, Elatinaceæ, Hypericaceæ, Malvaceæ, Tiliaceæ, Linaceæ, Geraniaceæ, Ilicaceæ, Empetraceæ.

Aquifoliaceæ or Ilicaceæ are sometimes included in Calycifloræ. Droseraceæ are included in Thalamifloræ. Empetraceæ are included in Apetalæ, amongst which Illecebraceæ are often ranked near Caryophyllaceæ. The Portulaceæ are placed in Calycifloræ by some authorities, and Paronychiaceæ are included in Illecebraceæ amongst Monochlamydeæ, but are by some included next the former in Calycifloræ.

Balsaminaceæ and Oxalidaceæ are sometimes included in Geraniaceæ.

The petals are more or less united below or meet together in the case of the Fumitories, Milkworts, Water-blinks, Tamarisk, Mallows, Holly, amongst Crassulaceæ in *Cotyledon*, and in the White Bryony.

The group Polypetalæ includes the Thalamifloræ, with perianth hypogynous, and the Calycifloræ, with perianth perigynous and epigynous.

1. THE BUTTERCUP GROUP (SUMMARY).

(*Introductory Volume, p. 34.*)

The order Ranunculaceæ includes about 700 species, distributed in about 27 genera, which are spread over the North Temperate Zone.

The members of this Order are chiefly herbaceous perennials, but a few are shrubs, as *Clematis*. They are frequently provided with a rhizome; the shoots are annual and flowering, a bud in the axil of the leaves serving for the next year's growth. Adventitious roots are formed when the primary root dies down, or tubers may be formed.

The leaves are alternate, sometimes with sheathing bases, and are often divided.

The flowers may be single and terminal. The inflorescence is usually cymose, and the flowers may be regular or irregular, and unisexual or bisexual. The flower is spiral on a long receptacle, or the perianth leaves may be whorled. The perianth is

frequently petaloid. In *Ranunculus* the distinction between calyx and corolla is well-marked. The nectaries often take the form of modified petals or stamens. The honey is secreted by the carpels in Marsh Marigold, in Bearsfoot and Winter Aconite it is secreted by the tubular petals, in Love-in-a-Mist by petals with a leafy end, in Goldielocks at the base of the petals, and in Upright Meadow Crowfoot also at the base of the petals.

In Monkshood and Larkspur the flowers are zygomorphic.

The stamens are spiral and indefinite. The anthers usually open outwards, except in the case of the Pæony. The carpels are indefinite, apocarpous, spiral. In Love-in-a-Mist the carpels are united. There is but one carpel in the Baneberry, which has a berry-like fruit.

In Meadow Rue the flowers are wind-pollinated.

Generally the anthers open first, and in opening the stamens bend outwards. In *Clematis* there is only pollen, in *Ranunculus* the flowers are actinomorphic and open, with honey more or less exposed. In the Columbine and Larkspur the honey is concealed in a long spur, and the flowers in the latter are zygomorphic.

As a rule the fruits are achenes or follicles, rarely capsules as in Love-in-a-Mist, or a berry as in Baneberry. In *Clematis* and *Anemone* the achenes are wind-dispersed.

The *Ranunculus* group has been split up into three

sections according to the number of ovules and character of fruit, *e. g.* where the ovules are many, the fruit a follicle, or a berry, or capsule, viz.:

Pæoniæ, with no honey-receptacles, usually solitary flowers, a fleshy pericarp, and a broad stigma, *e.g. Pæonia.*

Helleboreæ, with honey-glands, pericarp rarely fleshy, and with flowers solitary, in racemose inflorescences, or cymes, *e. g.* Marsh Marigold, Globe flower, Bearsfoot, Love-in-a-Mist, Winter Aconite, Baneberry, Columbine, Larkspur, Monkshood.

Ovule 1, fruit an achene.

Anemoneæ, *e. g. Anemone, Clematis, Ranunculus, Thalictrum.*

Another mode of grouping the various types is as follows:

Tribe I.—*Clematideæ*, sepals valvate, shrubs with opposite leaves, *Clematis* (see *post*).

Tribe II.—*Anemoneæ*, sepals imbricate, achenes with one pendulous seed, *Thalictrum, Anemone, Adonis, Myosurus.*

Tribe III.—*Ranunculeæ*, sepals imbricate, achenes with one ascending seed, *Ranunculus.*

Tribe IV.—*Helleboreæ*, sepals imbricate, follicles many-seeded, except in *Actæa*, flowers regular, follicles many-seeded, in *Caltha, Trollius, Helleborus, Eranthis, Aquilegia*, flowers irregular, follicles many-seeded, in *Delphinium* and *Aconitum*, flowers nearly regular, fruit a berry in *Actæa.*

The anthers are extrorse in all but *Actæa*, where

they do not burst, and in *Pæonia*, where they burst inwards.

Myosurus is included in Ranunculeæ by some, though the seed is pendulous (as in Anemoneæ).

The Ranunculaceæ are allied to Berberidaceæ and Papaveraceæ, and to Alismaceæ (amongst Monocotyledons), and Rosaceæ (amongst Calyciflorae).

The flowers are polygamous in Meadow Rue, the sepals are persistent, and the carpels united in *Helleborus*, the stamens are few in *Myosurus*, the follicle is solitary in *Delphinium*, and there is a solitary berry and a dilated stigma in Baneberry.

The group includes plants with acrid properties, and *Aconitum* is used medicinally to relieve pain in nervous disorders. It is deadly poison, as are some others, as Baneberry. The Buttercups have a blistering effect. Hellebore was formerly employed as an antidote for madness. *Ranunculus glacialis* possesses sudorific properties. The fruit of *R. thora* is deadly poison.

The following types of Ranunculaceæ are described in the introductory volume.

Wood Anemone	.	(*Anemone nemorosa*).
Water Buttercup	.	(*Ranunculus floribundus*).
Creeping Buttercup	.	(,, *repens*).
Lesser Celandine	.	(,, *Ficaria*).
Marsh Marigold	.	(*Caltha palustris*).

TRAVELLER'S JOY (*Clematis Vitalba*).

One irresistibly connects the Traveller's Joy or Old Man's Beard with the chalk downs, where it grows in tangled masses, forming arbours, fit shelter for bird, beast, or man.

As a matter of fact, it is only native on such soils as that of the chalk or Oolite, which are calcareous.

Common in the south of England, it does not grow north of Nottingham in a wild state. The Traveller's Joy is absent (as a native) from Ireland, and is not native in Scotland.

The sort of habitat it adopts is chalk downs, where there are many bushes and shrubs, such as White Beam, Wayfaring Tree, the Yew, and the Box. Here, too, are to be found many other lovely wild flowers, such as Orchids, that frequent a chalky soil. Elsewhere, Traveller's Joy may be found in thickets and hedge-rows, where there is some support for its weak and climbing stem.

This is one of its chief characteristics, for it is a climbing shrub, and cannot grow erect without the assistance of a sturdier plant.

Darwin showed that the leaf-stalks are sensitive to the slightest touch. He says: "I have found them embracing thin withered blades of grass, the soft young leaves of a maple, and the flower-peduncles of the quaking grass or Briza."

they do not burst, and in *Pæonia*, where they burst inwards.

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Creeping Buttercup .	(„ *repens*).
Lesser Celandine .	(„ *Ficaria*).
Marsh Marigold .	(*Caltha palustris*).

"The latter are about as thick as the hair of a man's beard, but they were completely surrounded and clasped. The petioles of a leaf, so young that none of the leaflets were expanded, had partially seized a twig. Those of almost all the old leaves, even when unattached to any object, are much convoluted, but this is owing to their having come, whilst young, into contact during several hours with some object subsequently removed. With none of the above-described species, cultivated forms of Clematis—there are some 170 species, cosmopolitan in range—cultivated in pots and carefully observed, was there any permanent bending of the petioles without the stimulus of contact. In winter the blades of the leaves of *C. vitalba* drop off, but the petioles (as was observed by Mohl) remain attached to the branches, sometimes during two seasons; and, being convoluted, they curiously resemble true tendrils, such as those possessed by the allied genus *Naravelia*. The petioles which have clasped some object become much more stiff, hard and polished than those which have failed in this, their proper function."

This plant is one of the leaf-stalk climbers. The leaf-stalk bends once round the support, and then thickens and becomes woody.

Darwin divided climbing-plants into four groups:

(1) *Twining plants*, which climb by twining round their supports, as in the case of Black Bryony, the Hop, etc.

(2) *Climbers* with sensitive organs, tendrils which

may be formed of stems, leaves, or parts or roots, and, as here, by the leaf-stalk in Clematis.

(3) *Hook-climbers*, which scramble over other plants, with hooks for support, as in the Bedstraw and Bramble.

(4) *Root-climbers* that climb by means of adventitious roots on the stems, *e.g.* Ivy.

So sensitive is the underside of the leaf-stalk that it embraces an object in contact within a few hours.

The stem of the Traveller's Joy is very long, angular, woody, and branched.

One of the characteristics of this climbing undershrub is the opposite character of the leaves. These are compound and pinnate, and consist of five leaflets which are distant, heart-shaped to ovate, usually entire or coarsely and unequally toothed. When twining, the leaf-stalk persists, but dies down and falls if not attached.

There is a sweet scent to the flowers, which are cymose and yellowish, or greenish-white. There are no petals, the sepals serving the purpose, being green externally, yellow within. They are four in number, valvate, and downy both sides. There are many stamens and carpels.

The fruit is a one-seeded achene, which is hairy, with a long feathery awn formed by the persistent style. The appearance of several of these together suggested the name of Old Man's Beard.

Flowers of the Traveller's Joy may be found in

Belly-wind, Bethwine, Binder, Bindwith, Bullbind, Climber, Crocodile, Devil's Cut, Grey-beards, Hag-rope, Honesty, Honey-stick, Lady's Bower, Lovebind, Love-entangled, Maidenhair, Maiden's Honesty, Old Man, Old Man's Beard, Old Man's Woozard, Robin Hood's Fetter, Silver Bush, Smoke Wood, Snow-in-harvest, Tom-bacca, Traveller's Joy, Hedge Vine, White Vine, Wild Vine, Virgin's Bower, Withwind or Withwine.

The name Devil's Cut alludes to boys' practice of smoking the dried stems. Another name is Devil's Thread, given in days when many plants were dedicated to the Evil One. The name Virgin's Bower was bestowed upon the plant at a later time, when many Christian epithets found their way into plant nomenclature, this name being given by Gerard "as fitting to be a bower for maidens, and with allusion, perhaps, to Queen Elizabeth, but not, as we might be tempted to imagine, to the Virgin Mary, in a Riposo, or resting scene on the way to Egypt, which is a frequent subject for pictures."

CLEMATIS VITALBA.—*In the illustration (Fig. 7) the tendrils, which are the petioles, are seen clasping a stem. The sepals are shown to be light-coloured, serving in the place of petals, and within are the numerous stamens.*

2. THE BARBERRY GROUP.

There are some eleven genera and about one hundred and fifty species of the order Berberidaceæ.

hedge, owing to the spinous modified leaves, in clusters of three, with leaves in the axils. The fruit also is luscious, and may be one reason for its former abundance. But regarded as a cause of wheat-rust by farmers before it was scientifically demonstrated, it has been rooted out of many of its former strongholds. There even existed an American law to prevent the spread of it, on account of the damage to crops.

The Barberry is a woody shrub, the wood yellow and acid, and the whole plant is without hair and pale green. There are long shoots with the leaves forming groups of spines owing to arrest of the branches, and short shoots in the axils of the spines, with leaves and flowers, and they may later become long shoots. The long spines form an example of adaptation to dry conditions, the spines not developing where moisture is abundant.

The leaves are alternate, and on the woody shoots shortly stalked. They are simple, but jointed to a short sheath and evidently originally compound. They are coarsely toothed and inversely ovate.

The flowers have the parts in threes, which is unusual amongst Dicotyledons, and characteristic of Monocotyledons—six sepals, six petals, six stamens. They are yellow, strong-scented, and borne in racemes, which are drooping and terminal. There are short, triangular bracts. The stigma is broad and black, and has no style.

The scarlet berry is oblong, flattened, and curved, contrasting strongly with the green foliage.

The Barberry is in flower in May and June, and is a herbaceous shrub, which grows to a height of four to eight feet.

The mode of pollination is interesting. The Barberry forms a good instance of a British wild flower, in which the stamens are sensitive and explode in contact with an intruding object, *e. g.* an insect.

Directly they are touched they shower the head of an insect with pollen, and if it goes to another flower this naturally leads to cross-pollination. The anthers are ripe first, and open by flaps opening upwards. The flowers contain honey in twelve orange honey-glands at the base of the petals, which are in alternate whorls. At first the stamens lie close to the petals nearly at right angles to the pistil, which is mono-carpellary, with two ovules, with a straight embryo. The stigma is covered with papillæ. The insect when hit by the recoiling stamens is apt to be driven away, and thus the pollen is at once carried away to be transferred probably to a fresh flower.

Bees, wasps, flies, and beetles are the chief honey-seekers.

The fruit is juicy, red, and attractive to birds, and thus the seeds are liable to be disseminated to a distance. The seed coat is hard, and the endosperm within the seed is also hard, preventing its digestion.

Another name is Pipperidge (French pepin, a pipe, rouge, red). The shrub was called Appendix by Pliny, from the drooping berries.

Formerly, in days of superstition by "doctrine of

signatures," the juice was considered a remedy for jaundice. The berries are acid and tart, containing malic acid, and used for preserves and tarts. A dye suitable for leather, linen, cotton and wool, permanent with alum, can be prepared from the bark. The bark is astringent, and has been used for tanning, and for Russian leather. The barberry bark has also been used in place of quinine. The berries have been eaten raw, dried, or boiled in wine for stomach complaints.

Barberry has been known in different parts by the following names: Barbaryn, Barboranne, Berber, Guild, Jaundice Berry, Maiden Barberry, Pepperidge, Piperidge, Piperidges, Piprage, Piperidge Tree, Rilts, Woodsore, Woodsour, or Woodsower.

Among Italians a species of Barberry bore the name of Holy Thorn, as it was supposed to have formed the Crown of Thorns.

Longfellow in his song of Hiawatha refers to the Barberry thus:

"Where the tangled barberry bushes
Hang their tufts of crimson berries."

BERBERIS VULGARIS.—*The illustration (Fig. 8), shows the plant in fruit, the shiny surface of the berries being well-shown. The innermost leaf-like leaves of the short shoots are seen in the axils of the spines, which are modified leaves.*

3. The Water Lily Group (Summary).

(*Introductory Volume, p. 49.*)

In this group, the order Nymphæaceæ, there are two British plants, *Nymphæa alba*, White Water Lily, with large petals, without a nectary, and stamens inserted on the surface of the ovary; *Nuphar lutea*, Yellow Water Lily (Introductory Vol., p. 51), with small petals, with a nectary, and stamens inserted below the ovary.

The members of this group are natives of the northern hemisphere, and are perennial, herbaceous, aquatic plants. The leaves are floating, or submerged, or aërial. The flowers are large and solitary. The parts are spirally arranged, and the sepals pass into petals, and the latter into stamens. The sepals and petals and stamens stand on a fleshy disc expanded upwards, surrounding and adhering to the ovary. The ovary is many-celled and contains many ovules. The stigmas are sessile and radiate. In the carpels are air-cells, which enable the fruits to float in the water.

The flowers are conspicuous, scented and attract insects, such as flies and beetles. The seeds are surrounded by a fleshy, slimy mass, and birds feeding on the fruit may carry some seeds away on their feathers. The stems in this group have the structure of Monocotyledons, and doubt existed at one time as to whether they were to be placed in this group or in

Dicotyledons, but owing to their two cotyledons they have been included in the latter.

The primary root is arrested. The current leaves (which develop before the rounded leaves) are narrow and bladeless, then spear-shaped, then round or shield-shaped, as in Aroids. These are adaptations to an aquatic habitat.

4. The Poppy Group.

The order Papaveraceæ consists of herbaceous plants, whose range is the N. Temperate Zone. There are some 28 genera and over 200 species. Many are annual. They have alternate leaves, and contain (except in *Fumaria, Corydalis, Dicentra*, if these be included in the group) a milky or yellow poisonous juice. The hardened juice forms the opium of commerce or morphia.

The flowers are usually regular, solitary, or in racemes, hermaphrodite, and (except in Californian Poppy) hypogynous.

The calyx is polysepalous and inferior, and the two sepals are caducous. The corolla is polypetalous and hypogynous.

The petals are four, crumpled in the bud. The stamens are numerous, with a long anther-stalk. The anthers open at the side by two longitudinal fissures. The pistil is syncarpous, the ovary 1-celled or unilocular, divided by many placentary divisions, which nearly reach the centre, radiating

from the outer walls—that is, with parietal placentation.

The capsule in the Poppy opens by pores at the top, below the rayed stigma, and is a "pepper-box fruit," the seeds being scattered by the wind, the flower-stalk with the terminal capsule being readily agitated by the wind, and the seeds, being small and numerous, are easily thrown to a distance.

The group is divided by some authorities into three sub-orders.

Hypecoideæ, in which the petals have no spur, and the stamens are four in number, the carpels two, including *Hypecoum*, a Mediterranean type, remains of which have been found in plant-beds of Preglacial age in East Anglia.

In the Papaveroideæ the stamens are indefinite or numerous, the carpels are two or numerous, and the group includes *Eschscholtzia*, *Chelidonium*, *Glaucium*, and *Papaver*. The two last are described *post*. A third group consists of Fumarioideæ, in which the petals are spurred, and in which there are two stamens with three branches. The sub-order includes *Dicentra*, *Corydalis*, and *Fumaria*. In this arrangement the last group is treated as a separate order—Fumariaceæ.

The capsule in *Glaucium* opens by two valves, splitting longitudinally. The fruit is two- to three-celled. The seeds of Poppies yield an oil. The petals are used as a narcotic, the juice as opium in the Opium Poppy. The seed is given to birds as

maw seed. The oil is used as a substitute for olive-oil.

The juice of the Greater Celandine has been used as a cure for warts. There is a short style in the Welsh Poppy.

Amongst British Poppies there are also the Welsh Poppy (*Meconopsis*) and *Rœmeria.*

PALE RED POPPY (*Papaver dubium*).

The name Poppy calls up visions of bright hot summer days, seas of standing corn, with a scarlet glare of colour here and there of poppies, which seem to make the corn more golden, despite their own rich colour.

All poppies are beautiful, and not all have those reputed qualities of dealing out death or sleep, like the Opium Poppy.

The one described is to be found in all parts of the British Isles, seldom higher than the limit of cultivated plants, or 1000 feet. Like other British species, of which there are six, all called colonists by Watson, the pale red Poppy is found in cornfields with other arable soil plants, such as Charlock, Fumitory, Corn Cockle, White Campion, Chicory, etc. Occasionally it grows in the hedgerow, or on the wayside sward, or the borders of fields.

The habit is erect, with many leaves below. The sap or juice is white and milky, not yellow as in *P. Lecoqii.* The hairs on the flower-stalk are not spreading, as in the common Red Poppy, but closely

pressed to the stalk. The leaves are deeply divided to the base, with rather remote, broad, and blunt lobes.

The flowers are large, pale red, with the four petals in two pairs, which are transversely oval, unequal. There are two sepals, which fall in the bud. The flowers are borne on very long stalks, and are terminal. The petals in bud are crumpled up. The stamens are numerous. The anther-stalks are awl-shaped. The disc of the stigma has a spreading edge, with 6–12 rays. The ovary is one-celled, but divided into more or less closed chambers, with parietal placentæ, or cushions, and contains many seeds. The capsule is inversely ovoid, oblong or club-shaped, narrower below, and is not bristly, but smooth; hence another name—Smooth-headed Poppy.

Like the other Poppies this one is a herbaceous annual, flowering between May and July, and is from one to two feet in height.

The Poppies are all pollen-flowers, and contain no honey. The anthers are ripe in advance of the stigma. Some pollen falls on the stigma whilst the flower is in bud in the Common Red Poppy, but as the stigma is taller than the anthers in this species the flower is not self-pollinated, but cross-pollinated.

The fruit is a capsule which opens above by pores, forming a pepper-box arrangement, the stigma covering the seeds above and protecting them from rain. When the flower-stalk is agitated by the wind the seeds are jerked out of the pores and scattered to a distance. The seeds are oily and albuminous.

The Poppy, sometimes called Corn Rose, was sacred to Ceres.

> "Sleep-bringing Poppy, by the plowmen hate,
> Not without cause, to Ceres consecrate."

Somnus, the god of sleep, is represented as crowned with Poppies. Poppies are the symbol of death.

Blaver, Blind Eyes, Cock's-head, Headache, Yedwark are names for this plant.

The figure of the cross was thought to be represented in the centre of the true Red Poppy

In an 'Early Calendar of English Flowers' the Poppy is referred to thus:

> "And Poppies, a sanguine mantle spread
> For the blood of the Dragon St. Margaret shed."

The Poppy was once used in love divination, a girl plucking a petal and striking it, noticing the force with which it broke from the stalk.

The juice was formerly used by herbalists as a cure for warts.

The Order of the Legion of Honour has a red ribbon of the colour of the Red Poppy, as chosen by the Empress Charlotte of Austria, consort of the Archduke Maximilian, she declaring that the Order of Nature was before the Order of the Legion of Honour in enclosing a poppy leaf in a letter to her husband, and choosing the colour of the petals as the colour of the ribbon.

PAPAVER DUBIUM.—*In Fig.* 9 *the flower, flower-bud drooping at first, and the long smooth capsule are shown,*

W. E. Mayes. FIG. 9.—PALE RED POPPY (*Papaver dubium*), flower and fruit. *See page* 82.

W. E. Mayes. FIG. 10.—RED HORNED POPPY (*Glaucium phœniceum*). *See page* 85.

with the hairs appressed, the peduncle being apparently smooth.

The pinnate leaves are shown with characteristic narrow segments.

RED HORNED POPPY (*Glaucium phœniceum*).

Like its congener, the Yellow Horned Poppy, a common plant along the sea-coast, the Red Horned Poppy is a lovely flower, and may be known by the same characteristic feature, the long horn-like pods. Another scientific name by which it is known (*G. corniculatum*) more or less denotes this, *corniculatus* meaning a little horn (being a diminutive of *cornu*, horn).

These two plants are natives of the Mediterranean region. The Red Horned Poppy is found in France, and the Palatinate of the Rhine, in Germany.

In this country it occurs rarely on cultivated ground, or waste places. The author has seen it growing on manure-heaps in a farmyard, and it grows also in the vicinity of mills, where foreign wheat is ground for flour, the winnowings and ballast being cast out as fowl-corn.

The stem is hairy, in which feature it differs from the native maritime species. Like the latter it is also glaucous (hence *Glaucium*) or bluish-green. This is due to a secretion of wax causing water to run off. The stem is more or less branched. The stem-leaves are much divided nearly to the base, the lobes cut.

The leaves are clasping, with a wavy border. The juice is yellow.

The flowers are scarlet, with black spots at the base. The ovary is two- or three-celled. The style has the stigmas bent back. The latter are opposite the placentæ or cushions on which the ovules, which are numerous, lie. The capsules or pods are linear, two-valved nearly to the base, long, narrow, and bristly. The seeds are numerous, embedded in the spongy septum, brown, with ridges, enclosing square areas.

The Red Horned Poppy flowers in June and July. It is an annual or biennial, and the plant is from 15 to 18 in. in height.

The conspicuous flowers render the Red Horned Poppy suited to cross-pollination. They are pollen-flowers, and in the absence of insect-visitors the plant is self-fertile to its own pollen. The flower in the Yellow Horned Poppy lasts two days and then the petals drop.

The long pods open by both valves and the seeds are blown away by the wind. The pod itself falls off when they are ripe.

GLAUCIUM PHŒNICEUM.—*In Fig.* 10 *the leaves, divided nearly to the base, clasping the stem, are well shown, and the radical leaves are seen to form a tuft. The flower is on a long stalk. The flower-bud is shown with the sepals enveloping the petals. The characteristic pod shows the terminal recurved stigmas.*

5. The Fumitory Group.

The Fumitories are natives of the Mediterranean region.

The Fumariaceæ are herbaceous, more or less succulent, slender plants, with a trailing or climbing habit. These plants are tender, smooth, glaucous plants with alternate, much divided, leaves, usually climbing.

There are small, irregular flowers. The stamens are six in number, with the filaments united or diadelphous, *i. e.* in two bundles. The calyx is polysepalous and inferior, with two sepals, deciduous or falling, or none. There are four petals, of which the outer pair are larger, one or both spurred, the inner pair united at the apex, thus forming a tube. The stamens are six, in two rows, hypogynous, or two, and tripartite, with three branches, the central one being perfect, the two lateral ones half anthers, or one-celled in the Fumitories. The stamens are opposite the outer petals. The style is slender, the stigma lobed with two or more points.

The ovary is syncarpous. The ovules are borne on two parietal placentæ or cushions, or there may be only one basal ovule by suppression. The fruit is a capsule or nut, and indehiscent, or a two-valved pod.

In the Fumitory the flowers are purple and the fruit is rounded, and a one-seeded nut, indehiscent. In *Corydalis* the flowers are yellowish-white or pink,

and the fruit is long and many-seeded or dehiscent, or a two-valved pod.

The group is allied to the Poppy group, but in the latter the corolla is regular, not irregular as here. The juice is milky also in the Poppy group, whereas in this group it is watery. The petals are swollen at the base in the Fumitories, and in *Corydalis* one is spurred.

None of the plants of this group are of economic importance, but they are beautiful plants with a graceful habit, and find a place in the garden. As a type of this order the Common Earth Smoke or Red Rampant Fumitory is described.

Of the Fumitories there are several species, divided into two groups, in one of which the lower petal is narrower gradually and slightly from the middle upwards, and in the other group, in which the common type described is placed, the fruit is not retuse, whilst the lower petal is distinctly spoon-shaped.

Common Fumitory (*Fumaria officinalis*).

No other plant can be confused with the Earth-smoke, as this plant is also called, for it has a distinct habit of its own, and the colour of the whole plant, apart from its structure and colour, is extremely characteristic.

It is common in all parts of the British Isles, but it is confined to the belt of cultivation, not growing above 1000 ft. even in N. England.

A certain habitat in which to find the Common Fumitory is a cornfield, where it is often frequent. Turnip fields are also suitable habitats in which to seek it. It grows very luxuriantly in the latter, with Charlock, Poppies, White Campion, Heartsease, Spurrey, Persicaria, Buxbaum's Speedwell, and other cornfield plants. In waste places it may often be found in great quantity. It is a colonist.

This plant is a leaf-climber. Darwin has so well described it that his remarks may be quoted with advantage on this point. He says: "It could not have been anticipated that so lowly a plant as this Fumaria should have been a climber. It climbs by the aid of the main and lateral petioles of its compound leaves; and even the much-flattened terminal portion of the petiole can seize a support. I have seen a substance as soft as a withered blade of grass caught. Petioles which have clasped any object ultimately become rather thicker and more cylindrical. On lightly rubbing several petioles with a twig, they became perceptibly curved in 1h. 15m., and subsequently straightened themselves.

"A stick gently placed in the angle between two sub-petioles excited them to move, and was almost clasped in nine hours. A loop of thread, weighing one-eighth of a grain, caused, after twelve hours and before twenty hours had elapsed, a considerable curvature; but it was never fairly clasped by the petiole. The young internodes are in continual movement, which is considerable in extent, but very

irregular; a zigzag line, or a spire crossing itself, or a figure of eight being formed. The course during twelve hours when traced on a bell-glass apparently represented about four ellipses. The leaves themselves likewise move spontaneously, the main petioles curving themselves in accordance with the movements of the internodes; so that when the latter moved to one side, the petioles moved to the same side, then becoming straight, reversed their curvature. The petioles, however, do not move over a wide space, as could be seen when a shoot was securely tied to a stick. The leaf in this case followed an irregular course, like that made by the internodes."

The stem is climbing (by aid of the petioles), erect or branched, delicate, pale green or glaucous, or bluish-green, is devoid of hairs, and the plant forms a dense tuft. The leaves are much divided, the segments flat, much divided, three-lobed, the lobes variable, linear to lance-shaped or oblong. The foliage is very distinct in character.

The flowers are rose colour, numerous, in a long raceme, which lengthens after flowering is over. The flower-stalk is longer than the bracts. The two sepals are lance-shaped to ovate, not so long or so broad as the corolla tube, with jagged edges, small and pink. There are four petals, the lower one spoon-shaped. The posterior one is slightly enlarged at the base into a spur, but the anterior one is not. They are really lateral, the flower being twisted in position a quarter of a circle. The inner petals are

hinged and attached only by the tip. These enclose the anthers, etc. There are six stamens, which are in two groups united by the stalks. The anthers of each middle stamen are two-celled, the others one-celled. The three stamens form three sides of a square, the stigma, which is horn-like, standing in the middle. There is a nectary at the base of the upper group of stamens. The ovary is one-celled and contains but one ovule, one not developing. The fruit is globular. The seed is albuminous with a very small embryo.

The Fumitory flowers from May to September, and is a herbaceous annual. It varies in height from 6 to 12 in. or 18 in.

As will be seen from the foregoing account of the floral mechanism, the Fumitory is adapted to insect pollination. The honey-gland lies in the enlarged base of the upper petal. The hinging of the middle petals enables an insect visitor to press them down, and as a result the insect, or, possibly, the stigma, is dusted with pollen. When the insect leaves the petals return to their position as before. The flower may be self-fertile. It does not seem to be visited by many insects, and not often by the hive-bee. It is adapted to visits by all kinds of insects, the honey being easily accessible, and this is assuredly necessary, for it flowers when many other attractive flowers are in bloom, and has often to rely on self-pollination, which is effective as each flower bears fruit. Bees visit the flowers, and, possibly, nocturnal insects.

The fruit contains but one fertile ovule, the other being suppressed. This may be an assistance in dispersal by the agency of the wind.

The Fumitory was called the Thunderer's Plant in Germany. Shakespeare calls the plant Fumiter, perhaps from the French *fume-terre*, or Latin *fumus terra*. The reason for the name Earth-smoke is suggested as due to the idea that it was produced without seeds. Pliny says that as smoke causes the eyes to water, so does Fumitory when applied to them.

Fumitory is also called Beggary, Earth-smoke, Fume-of-the-Earth, Fumiterre, Fumitory, Fumus-terre, God's Fingers and Thumbs, Snapdragon, Wax Dolls.

FUMARIA OFFICINALIS.—*In the illustration (Fig.* 11) *the foliage is well shown, being much divided. The raceme of flowers is just unfolding in the left branch, whilst fruit is developed in that on the right.*

6. THE CRESS AND CABBAGE GROUP (SUMMARY).

(*Introductory Volume, p. 53.*)

In the Introductory Volume the Cuckoo-flower (*Cardamine pratensis*) and Shepherd's Purse (*Capsella Bursa-pastoris*) are described as types of the important order Cruciferæ.

Seven other types are included here: Wormseed or Treacle Mustard (*Erysimum cheiranthoides*), White

The Author. FIG. 11.—COMMON FUMITORY (*Fumaria officinalis*). *See page* 88.

W. E. Mayes. FIG. 12.—WORMSEED (*Erysimum cheiranthoides*). *See page* 97.

Mustard (*Brassica alba*), Whitlow Grass (*Draba verna*), Awl Wort (*Subularia aquatica*), Pennycress (*Thlaspi arvense*), Sea Rocket (*Cakile maritima*).

These nine types are representatives of the subdivisions into which the order can be divided according to the character of the cotyledons or seed-leaves, and the character of the fruit, whether opening or not.

In the Siliquosæ or Crucifers in which the pods are longer by three to four times than broad, there are two groups. The pods open longitudinally from top to bottom, and are flat or swollen, not compressed, at right-angles to the septum. The pods are short in *Nasturtium*, however, and the top in *Brassica* does not open. In *Draba*, in the second group, the pod is a siliqua, longer than broad.

Amongst those divisions of the first group with seeds in one row (or in two in *Arabis* and *Nasturtium*), and in which the radicle is accumbent—that is, lying against the edges of the cotyledons in the embryo, which is curved—there is the Arabis tribe. The Cuckoo flower has been selected as a type of this tribe. It has a small stigma, which is terminal and simple, and flat pods with elastic valves. Other members of this tribe are the Seastocks, Wallflower, Water Cress and allied species, the Winter Cresses, the Wall Rockets, the Bitter Cresses, and Coral-root.

In the other tribe Treacle Mustard has been selected as a type. The seeds in the Hedge Mustard

tribe are in one row, the radicle is incumbent, lying on the back of one cotyledon, or parallel with the faces of the seed-leaves, straight and plano-convex. The other types are the Hedge Mustard and Dame's Violet. In Treacle Mustard the hairs are closely pressed, and forked two or three times, with a blunt stigma.

In the third tribe, or Cabbage tribe, we have selected White Mustard as a type. In this tribe the seeds are in one or two rows; the radicle is incumbent, folded lengthwise, or concave. The Rockets are the other members of this tribe. In the Cabbage group the pods are round in section, or angular. The seeds are in one row.

The second main group, or Siliculosæ, comprises the Crucifers in which the pods are not, or not much, longer than broad, and open throughout their whole length, being broad, flat or swollen, not flattened at right-angles to the septum, which is broad. But, as has been seen, the pod is longer in Whitlow Grass.

The Siliculosæ include two other tribes, in which the septum is narrow. The pods are also indehiscent in the third group, with Siliculose pods, and the valves are very short in *Isatis*, or are tomentose, as in *Crambe*, *Cakile*, and *Raphanus*.

In the Sweet Alyssum tribe the seeds are in two rows, and the radicle is accumbent. It includes Whitlow Grass, and *Erophila*, of which we have included Vernal Whitlow Grass as a type, Alyssum

and Scurvy grasses. In *Erophila* the petals are two-cleft, and the pods are oblong, flat, or swollen.

In the Gold of Pleasure tribe the seeds are in two series, the radicle incumbent, and the Gold of Pleasure and Awlwort are included here. The latter is the type selected, and is a small aquatic, with awl-like leaves, forming a rosette.

In the narrowly septate group the pods are short, and open from top to bottom, being flattened at right angles to the narrow septum. In Wart Cress the pod, however, does not open. This group includes two tribes, the Pepperwort tribe, in which the cotyledons are straight, bent inwards or folded lengthwise, with the radicle incumbent. The flowers of all these plants are white. In this tribe is placed Shepherd's Purse, described in the Introductory Volume, as a type with pods that open, with many seeds, the Wart Cresses and Pepper Cresses.

The other tribe, or Pennycress tribe, has straight seed-leaves, an accumbent radicle, pods on horizontal ultimate flower-stalks, and white flowers. Here are included the Pennycress, in which the pods are notched, the petals are equal, and the anther-stalks have no scales. This type is the one selected to illustrate this tribe. The Candytuft, Teesdale's Cress, and Hutchinsia are other members of the same tribe.

In the group Nucumentaceæ, in which the pods are indehiscent or have very short valves which cover a few only of the seeds, is included the Woad tribe,

in which the pods do not open and are one-celled and one-seeded. Woad is a type of this tribe, but not described here.

The other tribes of the indehiscent group include Lomentaceæ or the Sea Rocket tribe, in which the pods are transversely two-jointed, the lower joint not opening and it may be seedless or not, or two-valved and two- (or more) seeded, whilst the upper part is indehiscent and one- to two-celled. Sea Kale and Sea Rocket are included here, and we have described the latter as a type. It has the lower joint two-edged and one-celled, the upper sword-like, and one-seeded. The White Charlock tribe is represented here by White Charlock, which serves as our type. The pods are long, one-celled, contain many seeds, or do not open, or are jointed, the one-seeded portions being indehiscent.

The Cress and Cabbage group consists of herbaceous plants and a few under-shrubs, with leaves alternate and without stipules. The flowers are terminal in short racemes, or corymbose. There are four sepals, possibly two (as the other parts) by division. The stamens are six, four long, two short, or absent. There is a single style, with a pin-headed or lobed stigma.

The fruit is a pod varying in form as above, opening or not.

The flowers are honeyed, with glands at the base of the stamens. The sepals are erect and the honey is thus concealed and protected from rain, the floral

organs being close together, so that insects have to come in contact with anthers and stigma to get at the honey, touching the former on one side, the latter on the other. The anthers and stigma frequently ripen at different periods. But self-pollination often occurs in the flowers of this group, many being maritime plants.

The seeds are largely wind-dispersed in the case of the plants with dehiscent pods.

Variation in the character of the pods and the relation of the radicle to the cotyledons constitutes an important factor in classification.

The Cabbages and Cresses are important economically, and it is from this group that a large proportion of our vegetables and plants yielding condiments, as well as potherbs and salads, are derived.

TREACLE MUSTARD (*Erysimum cheiranthoides*).

Unlike most Cruciferous flowers, except the cabbage and allies, those of Wormseed are not white, but yellow, like those of the Wallflower (hence *cheiranthoides*).

Supposed to be wild in the Fens, this plant is found only in England and Ireland, where it is rare. The usual habitat is cultivated ground, waste places. I have found it most frequently on the outskirts of market-gardens, allotments, and gardens, and it seems to be on the increase. North of the Midlands

it seems to be a casual plant. Watson regarded it as a colonist in all cases. On waste ground the Treacle Mustard is found with Pepperworts, Penny-cress, and the ordinary waste ground plants. Another habitat is gravelly banks and fields.

The habit of the plant is erect. The stem is stiff, or rigid, with sharp angles, or round in section, and is somewhat hairy, the hairs being closely appressed to the stem. The leaves are almost stalkless, long, oblong, or are lance-shaped, narrow, tapering to the base into a short stalk, and not auricled as in *Sisymbrium,* entire or with few small teeth. The hairs are two- to three- partite, and stellate—that is, radiating from a centre.

The flowers are small, yellow, about a quarter of an inch across. The ultimate flower-stalks are two or three times longer than the calyx, shorter than the pods. The stigma is somewhat dilated at the top, and blunt. The style is short. The pods or siliquas are numerous, and borne on spreading stalks, being about an inch long, and twice or three times as long as the stalks, straight, with acute, strongly keeled valves. The seeds are very small and numerous, and nearly two-nerved.

The flowers are somewhat scented and fairly conspicuous. The honey is protected by the erect sepals, being secreted in honey-glands at the base of the short stamens, the petals being closed in wet weather. The anthers and stigma open about the same time, and as the style is short and the stigma enlarged

above, pollen must drop on its receptive surface as a rule, leading to self-pollination.

The siliqua opens upwards along both sutures when ripe, and the seeds attached to the central septum along the replum may be thrown to a distance when it contracts, or be blown away in a high wind, the slight wing above assisting in this operation.

The first Latin name is from the Greek *eruo*, draw blisters. The name Treacle is derived from theriakel, diminutive of therith, a little beast, the plant being, along with vipers, an ingredient in Venice treacle, or "Viper-wine." As the alternative English name implies, the plant was used as a vermifuge.

This plant is also called Treacle Mustard, Tarrify, Treacle Wormseed, Worm-seed.

ERYSIMUM CHEIRANTHOIDES.—*In Fig. 12 note the lanceolate, alternate leaves, the long flower-stalks, and spreading siliquas, which are long and linear.*

WHITE MUSTARD (*Brassica alba*).

When found by the sea coast or by river-banks or the way-side, the different species of Brassica may be native, as the Sea Cabbage. The rest of them are more or less all colonists.

White Mustard is general in the British Isles, south of Ross, in Scotland, but is rare in Ireland. It is found also in the Channel Islands. It is one of the ingredients of mustard and cress, and so may often be an escape.

The habitat, as in the case of the other species that are colonists, is waste or cultivated ground, cornfields. I have found it on railway embankments and in similar places. Chalky ground appears to suit it well.

There is no mistaking the habit of the Cabbage and Mustard. The stem is erect and furrowed, with ascending branches. The plant is smooth or hairy, with spreading or bent-back hairs. The leaves are pinnatifid, including the upper leaves, or lyrate, the terminal lobe being the largest, the lobes oblong, toothed; and the segments are also irregularly cut and lobed and rough.

The flowers are yellow and large. The stalks are spreading in fruit. The pods or siliquas are one to two inches long, stiffly hairy, cylindrical, beaded or knotted, not so long as the beak, which is sword-shaped, flat and stout, ribbed, sometimes curved, and is persistent, being one-seeded and hairy at the base, the hairs white. The valves are equal to the beak, and stiffly hairy, concave, five-nerved, the hairs obscuring the nerves. The cells are one- to three-seeded. The seeds are nearly round and pale with a yellow seed-coat or testa.

White Mustard flowers between June and August. It is a herbaceous annual. It is from 1 to 3 ft. in height.

The flowers are rather conspicuous, and contain honey at the base of the stamens. The anthers and stigma ripen more or less together. The plant is in

W. E. Mayes. FIG. 13.—WHITE MUSTARD (*Brassica alba*). *See page* 99.

Rev. C. A. Hall. FIG. 14.—A SIGN OF SPRING, WHEN THE VERNAL WHITLOW GRASS (*Draba verna*) FLOWERS. *See page* 101.

this way equally suited to self- or cross-pollination. Bees are the chief visitors.

The outer coat of the seed is furnished with a layer of mucilage. When wet this swells so that the seed adheres firmly to the ground. Germination experiments with mustard sown on flannel show this feature well, and it is shown even better in the case of cress. The siliqua opens when ripe, and the seeds are jerked from the replum, or blown away by the wind.

The name mustard comes from the Spanish Mastuerza; the Latin *nasturtium*, or *nasus*, nose; *tortus*, twisted, from the pungency of the plant and its effect. Mustard is grown in gardens as a salad with Cress (*Lepidium sativum*), or in fields near Wisbech and elsewhere for the condiment. The plant is ground up and mixed with water, when the strong flavour comes out. The oil cake is used as manure.

BRASSICA ALBA.—*Note in Fig.* 13 *the pinnatifid leaves with rather broad segments. The raceme shows the order of opening of the flowers; the lower ones, after having already opened, have been fertilised, and fruit has formed. Those above are oben or in bud.*

WHITLOW GRASS (*Draba verna*).

Diminutive or dwarf in stature, this little plant is wide-spread, and is found in all parts of the British Isles from the Orkneys to Cornwall, and in the

Channel Islands. In Yorkshire it ascends to an altitude of 1200 feet.

One knows where to seek for this lowly gem of a flower, for it has a great affection for the wall-top. I have seen it covering the sloping sides of a thatched roof in great profusion. The mud-wall, where also grow Wallflowers, Stonecrops, Shepherd's Purse, Thale Cress, etc., is its favourite haunt, and in some parts these primitive forms of enclosure still exist, but unfortunately for the botanist (and the artist's sense of the picturesque), the top itself is now being replaced by slates or cement, thus exterminating the mural vegetation. The same applies to thatched roofs, which are being replaced by tiles or galvanised roofing. But in these days of vandalism and jerry-building what else can one expect? Another favourite station for Whitlow Grass is a mole-heap, which also the cryptogamist will find a profitable hunting-ground for mosses, and on heathy sandy soil many ericetal lichens. Other habitats are the loose soil about railway-sidings, banks, and paths in gardens, or by the wayside.

This plant is one of those that may be regarded in the aggregate sense as a species with many forms, in the Benthamian sense, as is done by the "Lumpers," or, in the Jordanian sense, as a number of small species in the making, differing in the characters of the siliculas, as is done by the "Splitters." The modern tendency is to divide up these aggregates, owing to the theory of mutation

which recognises that species are even now, in spite of Darwin's opinion, in the making.[1] M. Jordan recognised seventy forms of this species, and when he cultivated them he found the characters constant.

The Whitlow Grass is a good example of a plant which has the rosette habit, with radical leaves, and the aërial stem leafless, in the form of a scape, specialised for bearing flowers only. The rosette habit is an adaptation to dry soil conditions.

There is a reduction of the area of the surface, and the radical leaves having the under-surface close to the ground, the stomata or pores, by which the plant transpires or gives off water vapour, derived from the water absorbed by the root from the soil, are not exposed to drought or to an excess of moisture. Frequently the margins are rolled inwards in such leaves, and there are hairs on the upper surface to protect the leaves from too intense heat or light. Such plants are also better rooted in the soil, and are frequently annuals, as in this case.

The radical leaves are ovate, lance-shaped, narrowed below, toothed or entire, hairy, the hairs branched. They are about an inch long, and more or less horizontal.

The flowers are white, borne on a leafless, smooth, or rarely hairy scape, which is wavy. The calyx is equal at the base. The petals are deeply notched. The stigma is sessile in fruit. The stamens are not

[1] *I.e.* that species are being formed by a quick, not a slow process, as Darwin held.

toothed. The stalks of the pods or siliculas are long, slender, unequal, and spreading.

The pods are flattened at the margin, inversely egg-shaped, lance-shaped, or elliptic. The pouch is oblong, not so long as the stalk, twice or more as long as broad. The valves are flat and membranous. The cells contain twenty to forty seeds.

The plant is also called *Erophila*, which comes from *ear*, spring, and *phileo*, love, referring to its early flowering habit. The name *verna* refers to the early flowering character, in spring, the plant being in bloom from March to June. It is a herbaceous annual, 1 to 6 in. in height.

In this species the anthers and stigma mature together. The four honey-glands are small, green and fleshy. They lie between the base of a short stamen and the long one which comes next to it, a short stamen standing between contiguous honey-glands. The long stamens are on a level with the stigma, which they closely encircle. Moreover, they open towards the stigma, so that it is regularly covered with pollen. Though the short stamens stand below the stigma, they also open inwards.

When an insect inserts its proboscis to reach the honey between the short stamens it thus dusts itself with their pollen and carries it away to another flower. In this way there are arrangements equally for self- and for cross-pollination. The flower is self-fertile, and since at so early a period of the year few insects but the hive-bee and some other

Hymenoptera visit the plant, it must usually be self-pollinated.

The siliculas open as in other Cruciferous plants, and the seeds are blown away by the wind.

The name Draba means acrid or blistering, from the taste of the plant.

The name Whitlow Grass refers to some former remedy the plant was considered to afford for whitlows.

Vernal Whitlow Grass is also called Faverel, Whitlow Grass, Nailwort, White Blow.

Gerard says: "It hath been taken to heale the disease of the nailes called a whitlowe."

DRABA VERNA.—*The habit of this plant is well displayed in Fig. 14, where the habitat is also shown. The plant is in fruit and the elliptic siliculas are clearly depicted.*

AWLWORT (*Subularia aquatica*).

Awlwort is unique amongst the Cruciferæ in adopting the aquatic habit (hence *aquatica)*.

The Awlwort is, moreover, scarce in the British Isles, occurring in the Highlands, the Lake District, North Wales, and the West of Ireland.

In the fresh-water aquatic formation Awlwort occurs as a submerged plant, in lochs and tarns of a highland character on siliceous rocks, where the water is poor in mineral salts. It grows on the shallow margins of such alpine ponds or lakes, where

the bottom is gravelly, and is extremely local. Its associates are Water Lobelia, Bladderwort, Lake-weed, and, amongst others with floating leaves, Quill-wort and Pillwort.

The habit is the rosette habit, and the plant grows under water. The roots have long white fibres, densely tufted and matted, the root-stock being small. The leaves are cellular, radical, slender, lance-shaped, pinnatifid, or entire, in clusters of one to three, long, round in section, and awl-like (hence *Subularia*). The plant is quite smooth.

The flowers are few, white, borne on a naked scape 1 to 3 in. long. Ten of them placed side by side would measure but an inch across. The petals are extremely minute. The stalks are short and ascending. The sepals are equal and spreading. The stigma is stalkless and entire. The pods are small, oblong, or globular, shortly stalked, the valves ribbed and convex. The septum is membranous. The seeds are few, five to six in each cell, in two rows. This plant differs from Draba in having the radicle or root portion of the embryo incumbent on the back of the linear cotyledons. It bends above their base, as in Wart Cress, not where they meet the radicle. The seeds are pale-brown and dotted.

The flowers are in bloom in July and August. The plant is a herbaceous perennial, and is not more than 3 in. high.

Sometimes the flowers, on the rather long aërial scapes, project above water, in which case they may

The Author. FIG. 15.—AWLWORT (*Subularia aquatica*). *See page* 10

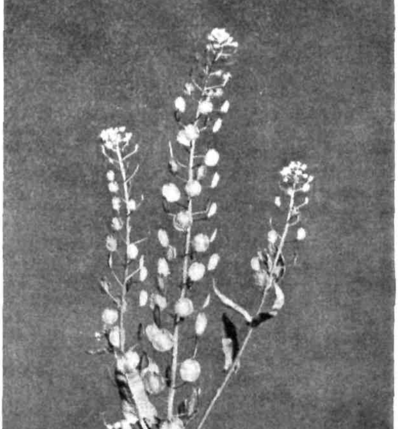

FIG. 16.—PENNY CRESS (*Thlaspi arvense*).
Messrs. Flatters and Garnett. *See* ;

rarely be insect-pollinated, *e. g.* by flies, if they open. But they are often closed, and cleistogamic, being self-pollinated under water. The anthers and stigma mature at the same time. According to Hildebrand they remain closed, and are self-fertile when the water is above the usual level.

The pods opening under water the seeds are dispersed by the agency of the water.

The only other name is Glond.

SUBULARIA AQUATICA.—*In Fig.* 15 *the general habit of the Awlwort is shown, with its quill-like or awl-like leaves, adapted to aquatic conditions. The shortly-stalked pods are also shown.*

PENNY CRESS (*Thlaspi arvense*).

Like many other Cruciferous plants, which are rich in nitrogenous reserve-materials, Mithridate Mustard, as Penny Cress is also called, is a colonist, according to Watson, and grows only where it has followed in the wake of man and the plough.

All parts of the British Isles furnish evidence of the extension of this plant within the limits of cultivation. It is, however, not so widespread in Scotland, and in Ireland appears to be confined to the Eastern counties. It is found also in the Channel Islands. Apparently it is more frequent on the Continent than with us.

The habitat of this plant is cornfields (hence *arvense*), cultivated ground generally, waste places.

It seems also to be a common plant in market gardens or allotments, where I have found it persistent from year to year. Where it does grow it is usually rather abundant. Penny Cress may also be found in fields and by the roadside.

In habit the plant is usually erect, and the stem is slender, simple, or branched above, hairless. The radical leaves are stalked, but they soon disappear, when the stem elongates. The stem-leaves are smooth, oblong or lance-shaped, arrow-shaped, the auricles well-marked, toothed, with a few coarse teeth, the lower narrowed at the base.

The flowers are white with erect sepals, equal below, and inversely ovate petals. The style is very short, so that the stigma is nearly stalkless.

The pods are borne in long racemes, and are flat, short, round, half an inch across, with a very broad wing and a deep notch at the top, in which the very small style is persistent. The silicula is not so long as the stalk, which is slender and spreading. The marginal nerve of the valves is delicate and the lobes of the wings at the notch may overlap. The seeds are numerous, six in each cell, dark, oblong, with ridges or arched wrinkles concentrically rough with striæ, dotted.

Pennycress is in flower from May to July, and is a herbaceous annual. It varies from 1 to 18 in. in height.

Honey lies in small green glands on each side of the short stamens. The anthers and stamens ripen

simultaneously. The longer stamens are level with the stigma and open inwards, so that they are instrumental in self-pollination when insects do not effect cross-pollination. But the shorter stamens shed their pollen below the stigma, and this is touched by an insect seeking honey, so that cross-pollination occurs. The arrangement here is as in Whitlow Grass.

The siliculas open when ripe, and the seeds may be blown away by the wind.

The name *Thlaspi* is applied to this plant in allusion to the flat pods like a penny (hence Pennycress). The word is derived from the Greek *thlao*, crush, flatten.

Mithridates, King of Pontus, is reputed to have invented an antidote for poisons which included some seventy-two ingredients, and amongst others, Pennycress. It was the custom in early times to make infusions of an enormous number of herbs (we say " there is safety in numbers "), as in the case of the drug Save (in which over fifty were included), to which Chaucer refers.

The old medicine-folk also included all sorts of things in their mixtures. In this primitive antitoxin, for instance, vipers and other reptiles played a part.

Pennycress has been called Boor's Mustard, Bowyer's Mustard, Churl's Mustard, Pennycress, Wild Cress, Dish Mustard, Treacle Mustard, Treacle-wort.

The name Dish Mustard owes its origin to Turner,

who says, "because the seede is lyke mustard seede in colour and in tast, and the vessel that coteyneth the seede is lyke a disshe."

THLASPI ARVENSE.—*In Fig.* 16 *the leaves below the raceme and the round large pods are figured. Here, as in the case of the Treacle Mustard, the uppermost flowers open last.*

SEA ROCKET (*Cakile maritima*).

Not an inconsiderable proportion of the Cruciferæ are maritime plants, as the one under notice, viz. Sea Cabbage, Isle of Man Cabbage, Jersey Cabbage, Hoary Brassica or Mustard, Small Alyssum, Sweet Alyssum, the Scurvy Grasses, Dittander, Woad, Sea Kale, Sea Radish.

Most of the maritime plants are fleshy and succulent, as an adaptation to the dry conditions, caused, not by drought in the ordinary sense, but by the unsuitable character of the soil water, so much so that the amount given off would exceed that absorbed, and so lead to wilting or flagging, were maritime plants not equipped with adaptations to resist such physiological drought as this is called. Physical drought is due to lack of water, as in the case of sandy or shallow soils.

Sea Rocket is found on most sandy sea-coasts in all parts of the British Isles up to Shetland, and in the Channel Islands. It also occurs on shingle. It may be found also in the sand dune formation,

forming an association of strand plants with Sea Kale, Sea Purslane, Oraches, Saltwort, etc., on the seaward side of the dunes, where the vegetation is halophilous or adapted to saline soil. Sea Couch Grass forms an association on some sand dunes, and here Sea Rocket may be found, with Yellow Horned Poppy, Sea Holly, and the like.

Like some other "strand plants," as those plants that frequent the areas just above tide-mark are called, this succulent, fleshy, glaucous plant is thoroughly adapted to its environment. In the same way, too, the habit is straggly, with zigzag, loose, ascending branches—a rather characteristic feature. The stem is rather woody below, hard, without any hairs, and erect or partly so, or prostrate. The leaves are fleshy, thick, not very numerous, entire, or divided nearly to the base, the lobes few, distant, oblong, or linear.

The flowers are like those of a stock, lilac or white, forming a corymb. The lateral sepals are entangled at the base. The flower-stalks are stout. The stigma has no style. The pods are borne on short, thick stalks, distant, in loose racemes, linear, lance-shaped, entire, in the young state, and when dry are ribbed, erect, with four sharp angles above, sword-shaped, not persisting, with one erect seed; the joints of the pouches are two-edged, the upper with two joints at the base, the seed pendulous. The pod does not separate into two valves, but the upper and lower parts are separated.

Sea Rocket is in bloom between June and August. It is a herbaceous annual, and is from 1 to 2 ft. in height.

The anthers and stigma are mature at the same time. The stigma is below the anthers, so that unless insects, which are not numerous on the sea coast, visit the plant it is usually self-pollinated.

The pods are indehiscent in the ordinary sense, but are in two parts, the upper of which with one seed falls when ripe near the plant.

CAKILE MARITIMA.—*In Fig. 17 note the entire leaves, with few lobes, and those with few distant lobes. The corymb shows the upper part in flower, the lower in fruit, which is entire, ribbed when dry, and erect.*

WILD RADISH (*Raphanus Raphanistrum*).

Probably this plant, and the one also found by the sea coast, is the origin of the garden radish, for M. Carriere raised forms of different colour from the seed of this plant, producing the long-rooted form in light soil and the round-rooted radish on a stiff soil. Pliny states the Greeks procured the two different varieties by growing them in different soils. When left to run wild these plants revert to the wild state. The Wild Radish is found throughout the British Isles.

As a colonist it is a follower of man, found on cultivated ground where cereals or root-crops are grown. In the cornfield it is associated with Char-

J. H. Crabtree. Fig. 17.—Sea Rocket (*Cakile maritima*). *See page* 110.

The Author. Fig. 18.—Wild Radish (*Raphanus Raphanistrum*). *See page* 112.

lock, which it closely resembles, except in the character of the pods. Poppies, Corn Buttercup, Fool's Parsley, Venus' Comb, Blue Sherardia, etc., are found in association with it.

The habit is similar to that of Charlock, cabbage-like. The root is slender. The stem is stout, erect, or spreading, branched, the base sparingly hairy. The leaves are simple, lyrate, the lobes larger upwards, pinnate, the segments few and distant, inversely ovate or oblong, coarsely toothed, rough, with short hairs. The upper leaves are narrow and entire.

The flowers are veined, distinguishing them from those of Charlock, lilac, white or straw-coloured, or white with lilac veins, light-yellow with darker veins. The calyx is erect. The pods are awl-like, or cylindrical when fresh, slightly narrowed at the joints, or moniliform, the beak flattened, awl-like, and longer than the pod, the beak formed by the style.

When dry the pods are longitudinally furrowed, and form a lomentum or schizocarp, breaking up into one-seeded portions. The seed is oblong, thick, narrow at one end. There is no endosperm the embryo filling the seed.

The Wild Radish flowers in June and July. It is an annual or biennial (the garden radish is biennial), and is from 1 to 2 ft. high.

There are four nectaries or honey-glands, as in *Brassica*. The anthers and stigma ripen together. The stigma is on a level with the short stamens.

Both long and short stamens open inwards. Self-pollination, in the absence of insects, is thus the rule. The hive bee visits it and the common Charlock.

The pods when ripe have no longitudinal septum, the seeds being separated by a kind of pith. The pod is a schizocarp, one-seeded portions breaking off at the joints.

The radish was used as part payment of the builders of the Great Pyramid, according to Herodotus.

The following names have been bestowed upon the White Charlock: Cadlock, Charlock, Jointed Charlock, Crawps, Curlock, Kedlock, Kellock, Ketlock, Wild Mustard, Rump, Runch, Skeldock, Skeldick, Skellie, Skellock, Skillock, Warlock.

RAPHANUS RAPHANISTRUM.—*Note in Fig. 18 the long awl-like cylindrical pods, which have a beak longer than the pod.*

7. THE MIGNONETTE GROUP.

There is no greater favourite in the garden than the Sweet Mignonette (*Reseda odorata*). It would doubtless surprise many that we have in the British Flora three plants that are akin to the garden plant which is a native of Egypt, and not unlike the one selected for description here, or the Wild Mignonette.

The order Resedaceæ comprises about half a dozen genera and nearly fifty species, natives of the Medi-

terranean region and other parts of Europe, Asia, S. Africa and California.

Annual or perennial, they are soft, herbaceous plants, with alternate leaves, and very small, glandular stipules. They are in many cases adapted to dry conditions. The flowers are hermaphrodite, in racemes or spikes. The calyx is inferior, with four to eight narrow sepals. The corolla is polypetalous and irregular; the petals may be absent, or up to eight in number, and are frequently much divided or torn. The stamens are numerous, three to forty, and hypogynous, inserted below the ovary on a glandular disc. The pistil is syncarpous. The ovary is single, open above, with short teeth, and terminates in a short style or stalkless stigma. The fruit is a capsule, open above and before it is ripe. The seeds are numerous. The embryo is curved, and there is no endosperm. The placentation is parietal.

Honey is secreted in the cup-like hollow of the disc when the flower is open. The petals protect it above from rain. The three upper petals form a lid, and the flower is a closed box, which is accessible only to insects that have a trowel-like tongue to prise it open, as happens to be the case with one of the bees.

The fruit is open above, and the seeds, which are black, smooth and glossy, are scattered by the wind. There are no members of this order that are of especial economic importance, but Dyer's Weed has been employed for dyeing, yielding a yellow dye, and sap-green has been made from the plant described

below. The garden mignonette is, moreover, a familiar plant in almost every garden. When prevented from flowering it becomes perennial, and may survive the winter, even without this precaution. The Dyer's Weed is distinguished from the White and the Wild Mignonette by its linear leaves, and the last has greenish-yellow petals, leaves with few segments, whereas in the White Mignonette the flowers are white, and the petals all divided with some of them as in Wild Mignonette, and the segments of the leaves are many.

WILD MIGNONETTE (*Reseda lutea*).

Belonging to the Mignonette family, this plant is also called Cut-leaved Mignonette, a name which refers to one of the chief distinctions between this plant and Dyer's Weed or Weld (*Reseda Luteola*). The Latin name *lutea* refers to the yellow colour of the flower.

Wild Mignonette is general in the British Isles, and is found in the Channel Islands.

Chalky districts or tracts of Oolite, and, as a rule, high ground, with rather a dry soil, are the special habitats of this plant. It occurs also on limestone. On the chalk the subsoil and soil is often sandy, and the plant occurs as frequently in sandy areas—a characteristic of many chalk plants. It is not regarded as a native, and is frequently found on waste ground, or where there is evidence of cultivation. I

have found it also by the wayside and about railway-sidings.

The habit is erect or ascending. The stem is branched, ribbed, covered with papillæ, but smooth. The leaves are twice or thrice deeply divided to the base, or pinnate, and are variable, the segments being also divided, blunt and oblong or linear, few and distant, with a wavy border.

The flowers form a dense conical raceme, and are pale yellow. There are six or rarely five linear sepals, which are unequal, the upper being smaller. The upper petals have a two-lobed claw, and a limb divided into three nearly to the base, the lower entire or two-cleft. The two upper petals have two wing-like lobes, and the lateral petals have but one wing. The flower-stalk is longer than the calyx. There are many stamens and three stigmas. The capsule is oblong, with three to four very short teeth, wrinkled. The seeds are inversely ovoid, and black.

From June to August is the period of flowering. The plant is a herbaceous biennial. It is from 1 to 2 ft. in height.

The flowers are yellowish, with many stamens and much pollen, and honey is secreted in a cup-like hollow in the disc which is protected by the three upper petals, of which the central is narrow and club-shaped, forming a lid which closes the honey-glands in a sort of box, and insects must open the lid to get at the honey—a feat which is performed by a bee with a flat trowel-shaped proboscis, used by it in

plastering up its cell. Prof. Wilson thus considers this an instance of a flower adapted to cross-pollination by short-tongued insects. The anthers open as soon as the honey commences to collect. The stamens bend inwards towards the stigma, which ripens at the same time, so that there is every possibility of self-pollination, but it does not appear to be effective. The flower is visited by a fair number of insects for its honey.

The capsule is leathery, open above, and the seeds are blown out by the wind.

It has been stated that this plant is Dyer's Weed or Weld, and that it yields a yellow dye, but this applies to *Reseda Luteola.*

The meaning of *Reseda* is to assuage, due to a belief that some of the species were instrumental in mitigating pain.

Pliny held that it charmed away various disorders, that it grew near Rimini (formerly Ariminum), and when used to reduce inflammation it was customary to spit three times and to repeat these lines.

> "Reseda, cause these maladies to cease ;
> Knowest thou, knowest thou, who has driven these pullets here ?
> Let the roots have neither head nor foot."

The only names by which it is known are Base Rocket, Crambling Rocket.

RESEDA LUTEA.—*The erect habit is well shown in Fig.* 19, *and the raceme is seen to be crowded with numerous flowers.*

Messrs. Flatters and Garnett. FIG. 20.—ROCKROSE (*Helianthemum vulgare*). *See page* 120.

8. The Rockrose Group.

In the British Isles the order Cistaceæ includes only the Rockroses, of which there are several species, and the common one has been selected as a type of the order.

There are four genera and over one hundred and fifty species throughout the world, three being natives of South America, the rest of the Mediterranean region, South and West Europe, North Africa.

In this group are included the Gum-Cistuses of the garden. Gum Ladanum or balsam is derived from *Cistus creticus*.

The Rockroses are herbaceous, or shrubby plants. Many are addicted to a dry soil, with wiry stem and rolled back leaves, and glandular hairs, and are undershrubs. Some are calcicole or confined mainly to chalk or limestone soil.

The leaves are frequently opposite, in some exotic types alternate and entire, with or without stipules. In *Helianthemum guttatum* there are stipules in the case of the upper leaves, which are narrow-based, none in the case of the lower leaves, which are broad-based. The stipules thus serve to protect the buds in the axils.

The flowers are solitary, or in terminal racemes or cymes. They are regular and hermaphrodite, with male and female elements in the same flower.

The calyx is polysepalous, with three or five sepals, the two outer smaller than the inner, overlapping in

bud, and regarded by some as bracteoles, which are found, however, below them. The calyx is inferior and persistent. The corolla is polypetalous and hypogynous.

There are five petals (or three or none), convolute, overlapping to right or left, and the sepals do so in the opposite direction. The petals are fugacious, and broadly spreading. They turn towards the sun, hence the name " Sunflower," and close and open at certain times. The stamens are indefinite, free, hypogynous. They develop in descending order. The pistil is syncarpous. There is a single ovary and style, with three stigmas. The ovules are numerous, or two in each carpel. The capsule is one-celled, incompletely divided into several cells. In *Helianthemum* the capsule is three-valved.

The flowers do not contain honey, and are visited for pollen by many insects. The stamens are sensitive in some cases, and the flower may open and close by movements of the sepals. The anthers and stigma ripen in some cases at different periods.

The Rockroses are favourites in the garden. They are of no other economic importance so far as the British plants are concerned.

Common Rock Rose (*Helianthemum vulgare*).

There are several plants whose flowers turn towards the sun, by a process termed *heliotropism*, which is the movement of a plant owing to the influence of

FIG. 19.—WILD MIGNONETTE (*Reseda lutea*).
Messrs. Flatters and Garnett. *See page* 116.

The Author. FIG. 21.—SEA HEATH (*Frankenia lævis*). *See page* 12

light, or the direction of the incident rays of light, on the direction of growth. Some flowers respond to the stimulus of light on the direction of their growth by turning towards the light, and are called positively heliotropic. The Rock-rose is one of these, and for this reason it was called *Helianthemum* (*helios*, sun, *anthemos*, flower). It seems to have been named Rockrose from its predilection for stony and rather dry ground.

The plant is found commonly in England and Eastern Scotland, but not in Ireland. It grows up to an altitude of 2000 ft.

Wherever there is chalk or limestone, limestone scrub, calcareous grassland or limestone grassland, chalk grassland, or chalk pasture, the Rockrose will be found. It is also found where igneous rocks crop out where there are lime felspars, the two floras being closely akin in some respects. The habitat is thus dry hilly pastures and meadows.

In habit the Rockrose is a prostrate, spreading undershrub. The stem is short and woody. The flowering branches are annual and prostrate or ascending. The leaves are shortly-stalked, opposite, green, with hairs above, white and downy below; the borders flat or nearly so, oblong or ovate to lance-shaped, but vary in shape and the amount of pubescence. There are linear to lance-shaped stipules. Lord Avebury found that where the leaves are broad at the base, and thus capable of protecting the buds in their axils, there are no stipules. But

where the leaves are narrow below the plant has stipules. This fact is well exemplified in the Spotted Rockrose, *H. guttatum*, in which the lower leaves are opposite and broad-based without stipules, and the upper are narrow at the base and bear stipules.

The flowers are yellow, loosely racemose, with narrow bracts on the flower-stalks, which are bent down before and after the flowers open. The flowers bend over in wet weather and open in the sun, following it in direction.

The three larger sepals have three prominent ribs, and are membranous between; the two outer are very small, the inner are blunt, have a short point, and all are nearly smooth. The petals are broad and spreading. The style is bent upwards at the base, and longer than the ovary. There are more than 100 stamens.

The flowers are conspicuous, and though without honey, yield much pollen. The anthers and stigma (which is large and pin-headed) ripen at the same time, the stigma being a little longer than the stamens, which stand close around it. The latter are sensitive and bend outwards when touched (not inwards as in the Barberry). Hence an insect approaching from the outside is dusted with pollen. The method which is most favourable to cross-pollination is for the first insect to approach from outside and for subsequent visitors to alight in the middle. An insect visiting it first is brushed with pollen, which in the next flower, if it alights in the middle, will touch the

stigma and lead to cross-pollination. If insects are excluded, as in wet weather, the flower is self-pollinated as the petals close up and the crowded stamens touch the stigma.

The capsule opens by 3–5 valves, and when ripe the seeds are blown out or fall to the ground. The seed-coat is mucilaginous, and this makes the seed adhere to the earth, and helps to affix it.

The following names pass muster in different parts of the country: Rock Rose, Sol-flower, Sun Daisy, Sunflower, Sun Rose.

HELIANTHEMUM VULGARE.—*The Rockrose is well depicted in Fig. 20, which shows the undershrub habit, the opposite leaves with stipules in the axils. The root-stock is woody. The fugacious character of the petals is also shown, and the "turn sole" nature of the flowers, which face the sun.*

9. THE VIOLET GROUP (SUMMARY).

(*Introductory Volume, p. 60.*)

The order Violaceæ has been described in the Introductory Volume, the Sweet Violet being selected as a type.

With the Violets are included the Pansies, of which, like the former, many are favourites in the garden. In the violets the flowers are blue or white, in the latter they are usually tricolorous, or white, yellow, and blue.

Some 300 species of this order are known, distributed amongst fifteen genera, of cosmopolitan

distribution. The exotic forms are sometimes trees or shrubs, with small, nearly regular flowers.

The Violet group includes both annual and perennial plants, herbaceous or shrubby in habit. The leaves are radical or alternate, usually entire, and possess stipules, which are entire, or divided as in the Pansies.

The flowers are few in the axils, or radical, in racemes, with bracteoles. They are hermaphrodite. The calyx is polysepalous and inferior, persistent, with five sepals. The corolla is polypetalous, irregular, with five spreading petals, hypogynous, the anterior or lowest petal often spurred. There are five stamens which are hypogynous, are alternate to the petals, and form a ring around the ovary, with short broad anther-stalks. The anthers are borne on their inner surface, and open inwards, the two lower being spurred below. The pistil, which is syncarpous, consists of three carpels. The style is single, with a swollen, thickened or hooked, oblique stigma. The ovary is one-celled, with many ovules, and many-seeded. The capsule opens by three valves, folded lengthwise.

The lower petal, which is prolonged into a spur, contains the honey. The five stamens have appendages into which the pollen falls, and the two lower ones project into the spurred petal. The stigma closes the opening to the flower, giving it the yellow eye, and is like a bird's head in shape. Insect visitors touch the stigma first, then the anthers, and the pollen they withdraw is applied to the stigma of the

next flower. Usually bees pollinate them. Except in the Pansies the showy spring flowers do not set seed, but the autumn closed flowers, termed cleistogamic, and bud-like, do so, the flower being in this case self-pollinated.

The valves of the capsule contract and the seeds are jerked out to a distance. The Violets and Pansies are favourite garden flowers. Ipecacuanha is derived from the Violet.

10. The Sea Heath Group.

There are two plants in the British Flora belonging to the order Frankeniaceæ, of which the commoner one is selected as a type.

They are maritime plants or halophytes, distributed over North Africa and South Europe, adapted to what is termed physiological drought, or a condition in which the soil-water is inimical in great quantities to the well-being of the plant owing to the superabundance of mineral salts. A similar state of things is characteristic of moors and bogs, where the peaty soil is similarly charged with humous acids, which affect and reduce absorption, and therefore the plants must adapt themselves so that transpiration is not in excess of absorption. This is achieved by a reduction in leaf surface, and by other means, and the effect of heat is counteracted by the provision of a coat of wax, overlapping leaves, a covering of hairs, etc. Physical drought, on the other hand, is directly due to a lack of water in the soil.

The number of Sea Heaths is not great, between thirty and forty species, placed in four genera.

The plants are perennial, sometimes annual. The stems are herbaceous, or woody and wiry, and the plants may be undershrubs or shrubby. The branches are jointed. The leaves are small, opposite, linear, with inrolled margins, with no stipules, with a membranous sheathing base.

The flowers are numerous, stalkless, in dichasial cymes, in the upper axils. They are small, regular, and hermaphrodite.

The calyx is tubular, persistent, with four to six or seven sepals, induplicate in bud. There are four to five petals, with long claws and adnate scales between the claw and the limb. They are hypogynous and overlap in the bud. There are four or five stamens, or six, in two whorls, slightly united at the base, and alternating with the petals. There may be two or three opposite the latter. The anthers are versatile. There is no disc. The ovary is single, stalkless, one-celled. There is one slender style, two- to four-cleft. The stigma is two- to five-lobed. The capsule is one-celled, loculicidal, opening by three to five valves, enclosed in the persistent calyx. The seeds are minute, attached to the edges or centre of the valves.

The Sea Heath group agrees in habit with the Pink or Stitchwort group, in having parietal placentæ, and is related to the St. John's Wort group in the valvate calyx, definite stamens, and habit. It has affinities with the Tamarisk group.

There are no properties of any economic importance possessed by the plants of this order.

SEA HEATH (*Frankenia lævis*).

As the first part of the English name of this rather rare or local plant implies, it is a maritime species, and heath-like in adaptation, having ericoid or narrow leaves as a means of meeting the dry conditions in its particular habitat.

Very rare as a whole, it occurs on the south and east coasts of England, from Norfolk to Kent. It grows in the salt-marsh formation, on sandy soil in the Sea Rush association, with Sea Milkwort, Sea Plantain, Buckshorn Plantain, Couchgrass, and in the Marams or general salt-marsh association, with Scurvy Grass, Sea Spurrey, Sea Aster, Sea Wormwood, Sea Lavender, etc. I have found it in the Blakeney area only on the laterals to the main shingle bank to the east of the watch-house. Elsewhere it is found on sandy coasts.

The habit is that of a prostrate undershrub. The stem is slightly downy, dark green, much-branched, the branches wiry. The leaves are linear, oblong, but rolled back at the margin and so linear, adapted to drought, and are crowded in opposite clusters or whorls, smooth, fringed with hairs at the base. The leaves are sometimes pulverulent or powdery.

The flowers are few, rose-coloured, stalkless, terminal, in heads or spikes in the axils.

The calyx is furrowed, and hairy between the

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The flowers are few, rose-coloured, stalkless, terminal, in heads or spikes in the axils.

The calyx is furrowed, and hairy between the

prominent angles, about half as long as the leaves. The sepals form a tubular structure with four to five teeth. The petals are small, four to five, with long claws and spreading limb. The capsule is 3-angled. enclosed in the persistent calyx, 3- to 5-valved. The seeds are very small, oblong, with a linear raphe, and the seed-coat is hard, thin, and brittle. The embryo is straight, surrounded with albumen.

The Sea Heath flowers in August. It is a perennial undershrub, and, as a creeping plant, reaches no height.

The style is slender and forked, and the stamens are in two whorls of six united below by the stalks. The anthers are versatile. The flowers are dichogamous, stamens and stigma ripening at different times. The flowers are bisexual and regular. In all respects cross-pollination is favoured if insects visit the plant, but they do not seem to do so frequently.

The capsule being enclosed in the calyx may, when ripe, be wind-dispersed.

The only names are Frankwort and Sea Heath.

FRANKENIA LÆVIS.—*In Fig. 21 the Sea Heath is depicted, showing the trailing habit and the heath-like, linear leaves.*

11. THE PINK GROUP (SUMMARY).

(*Introductory Volume, p. 65.*)

As a type of the order Caryophyllaceæ, the Greater Stitchwort, *Stellaria Holostea*, was described and figured in the Introductory Volume of this series.

Two groups have been made in this order according to the character of the calyx.

In the group Silenoideæ, the flowers are gamosepalous and hypogynous. The sepals are united into a tubular or bell-shaped calyx. The group includes *Silene, Lychnis, Gypsophila* (not British), and *Dianthus.* As a type of this group Ragged Robin is described in this volume.

The other group, Alsinoideæ, comprises those members of this order in which the flowers are polysepalous, and the stamens are frequently perigynous.

The sepals are free, or only very slightly connected at the base. The Greater Stitchwort belongs to this group, and Field Chickweed—the latter also described in this volume.

By some authorities a third group is made to include *Polycarpon,* with membranous stipules, as in *Spergula* and *Spergularia.* Others unite here the Paronychiaceæ, including *Corrigiola, Paronychia, Illecebrum, Herniaria, Scleranthus,* and two other foreign types, in which the fruit is an achene or nut. They are included in the Illecebraceæ by Bentham and Hooker, whose system is largely followed in this country.

There are about thirteen hundred species and sixty genera of plants of this order, which are world-wide in range. The British types are enumerated in the Introductory Volume.

As a whole, they are herbaceous, or in some cases undershrubs. The leaves are mainly opposite, entire,

with stipules in some cases. The nodes of the stem are frequently swollen.

The inflorescence is frequently a dichasial cyme, or a cincinnus, and centrifugal. The flowers are regular and hermaphrodite, but the floral members are not always equal in number. A few types are apetalous; usually the parts are in fives, or in threes, or twos or fours, united. The stamens are twice as many. There is occasionally an elongation of the axis or androphore, between the calyx and corolla, which bears the ovary, stamens, and corolla. In some species of Campion the petals have a ligule.

Honey is secreted at the base of the stamens, the flower is wide open in the Alsinoideæ, tubular in the Silenoideæ, so that in the former the floral mechanism is adapted to short, in the latter to long-tongued insects. And Butterflies and Moths visit the latter, some flowers being nocturnal, scented at night, and red or white, or attractive to butterflies. As a rule, the anthers ripen first. The capsule opens by teeth, and is typically a "censer fruit," the seeds being wind-dispersed.

RAGGED ROBIN (*Lychnis Flos-Cuculi*).

Not only is this a familiar flower, but it is also one of our most beautiful plants, a mass of the pink blooms forming a lovely picture in the moist hollows in which it loves to grow.

Found in all parts of the British Isles, Ragged

Robin ascends to nearly 2000 ft. in the Highlands. It occurs also in the Channel Islands.

The habitat of this plant is moist or marshy meadows and pastures, damp places generally, copses, and ditches, or borders of streams. It is associated with Marsh Marigold, Cuckoo-flower, Lesser Spearwort, Square-stalked St. John's Wort, and other plants that prefer a damp or moist habitat. It is to be found on clayey and loamy soils where there is an association of the Common Rush, with Meadow Sweet, Creeping Jenny, etc. The marsh-formation is another habitat, and it occurs in the fen association of East Norfolk, in the valley fen, and amongst Arctic Alpine vegetation where subalpine plants grow in the pasture zone.

The habit is erect, with a short, slender rootstock, little branched, the stem brownish-olive, smooth, or rough above, or downy below, the hairs bent downwards, and sticky above to keep ants away from the flowers. The radical leaves are stalked, oblong to lance-shaped, with a long point. The stem-leaves are narrow.

The flowers are pink or rose-coloured, drooping, in loose, terminal, branched panicles, on short, slender stalks, the calyx having five short teeth and ten purple veins. The petals are four-cleft, the crown bi-partite, with erect, awl-like, palmately spreading segments, the two middle the longest, with an acute tooth in the middle of the outer margin, and long two-fid scales. The capsule is nearly round, and

opens by five teeth, being one-celled, with a very short carpophore. There are five styles.

The Ragged Robin flowers in May and June. It is a herbaceous perennial, which is from 1 to 2 ft. high.

The flowers contain honey, secreted by the base of the stamens, the honey-glands forming a fleshy ring. The anthers ripen before the stigma, the five outer ones maturing first, and opening inwards. The calyx-tube is 6–7 mm. long and the erect teeth are 3 mm. long, supporting the claws of the petals. Insects with a proboscis of 9–10 mm. long can reach the honey.

The tube is wide enough for a butterfly to pass its tongue down, but the anthers fill up the cavity, and thus usually dust the insect's tongue with pollen. When the outer stamens lengthen they bend outwards between adjacent petals; the inner stamens take their place in the entrance to the flower. After they wither the styles lengthen, and the stigmatic papillæ which cover the inner side of the stigma become receptive. The styles equal the corolla and are spirally twisted at the end (one and a half to two turns), and thus present a wide front to a visiting bee, butterfly, or fly.

The capsule is a "censer fruit," and the seeds are blown out when the stalk is agitated by the wind or by passing animals.

Ragged Robin is called Bachelor's Buttons, Meadow Campion, Cock's-caim, Cock's-comb, Crow-flower, Cuckoo, Cuckoo-flower, Fair Maid of France,

G. B. Dixon. FIG. 22.—RAGGED ROBIN (*Lychnis Flos-cuculi*). *See page* 130.

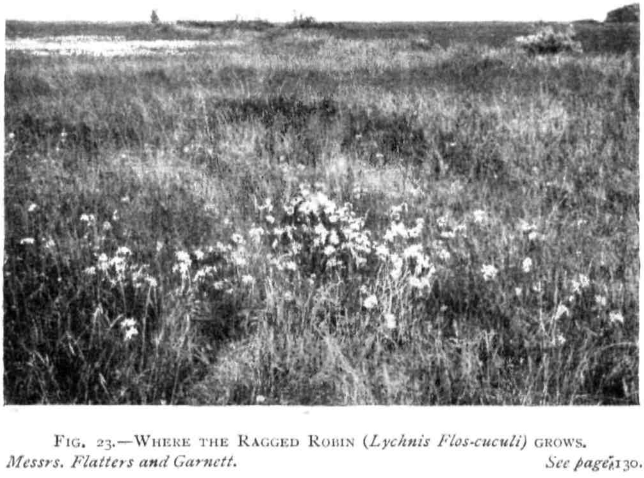

FIG. 23.—WHERE THE RAGGED ROBIN (*Lychnis Flos-cuculi*) GROWS.
Messrs. Flatters and Garnett. *See page* 130.

Cuckoo Gilliflower, Indian Pink, Marsh-Gilliflower, Meadow Pink, Pleasant-in-sight, Ragged Jack, Ragged Robin, Robin Hood, Rough Robin, Meadow Spink, Wild Williams.

The time of flowering is thus described in the 'Early Calendar of English Flowers':

> "When S. Barnabie bright snubs night and daie,
> Poor Ragged Robin blossoms in the haie."

It is possible that this is, however, Red Campion.

It is the Cuckoo's plant, and called also Geuky flower in Devonshire, Gowk or Geuk being a cuckoo.

LYCHNIS FLOS-CUCULI.—*In Fig. 22 the erect stems are seen to bear branching panicles of flowers with four-cleft petals, with a bipartite crown; and in Fig. 23 the habitat, a moist meadow, is depicted.*

FIELD MOUSE-EAR CHICKWEED (*Cerastium arvense*).

Not so wide-spread by any means as the Common Mouse-ear Chickweed, this species is a much more handsome flower, larger than any of the others.

Not common by any means, it occurs in all parts of the British Isles, though it is apparently less frequent in Scotland and local in Ireland.

Hilly districts seem to suit this plant best, as it is addicted to a dry soil, being found in sandy fields, dry hilly fields, pastures, and banks, gravelly and chalky fields. The name *arvense* indicates that it is found in arable fields and waste places, but more

probably it was there in such instances before the plough was ever at work, for it is a distinctly native plant. It occasionally occurs on dry grass heath, and, like some other sand plants, is found also upon the chalk or calcareous soils on chalk pasture. I have found it on the summits of the knolls of hills rising to 700 ft. on calcareous sandstones.

This plant has a tufted habit with ascending stems and branches, and is hairy all round the stem, which is much-branched, the branches wiry, interwoven and prostrate, the flowering branches ascending. The leaves are crowded below, narrow, linear to lance-shaped, smooth or slightly clammy.

The flowers are large, white, three to fourteen, in loose, forked panicles or cymes, on long stalks. The calyx is shorter than the petals, and the sepals are rather acute, oblong to lance-shaped, glandular, with membranous tips and margins. The fruit-stalks are erect, bent just below the calyx. The bracts have membranous tips and margins and are lance-shaped. The capsule is oblique or inclined, longer than the calyx at length, the seeds small with acute tubercles.

The flowers open in April, and may be found as late as August. The plant is a herbaceous perennial. It is 6 to 10 in. high.

The honey is half-concealed. The flower and its mechanism resemble that of Greater Stitchwort (*vide* Introductory Volume). In addition to hermaphrodite or bisexual flowers, some others occur in which the stamens are rudimentary. The honey-glands are

yellow, and lie on the outer side of the outer stamens with a honey-secreting pit above. The flowers develop in three stages, the outer stamens first, then the inner lying round the centre of the flower and turning their pollen-covered anthers upwards. In the first stage the three stigmas are bent inwards, in the second they are erect, with the papillæ turned towards each other, and in the third they turn outwards, so that cross-pollination is most likely if insects visit the flowers, though self-pollination may occur by the stigmas touching the inner anthers (still pollen-covered), if insects do not come to the flowers.

The capsule opens above, being a "censer fruit," and the seeds are dispersed by the wind, when the stalk is agitated by it, or by passing animals.

CERASTIUM ARVENSE.—*The habit of the flower is well illustrated in Fig. 24, and the calyx is seen to be less than the corolla, with notched petals. The essential parts of the flower are visible in the sub-central flower.*

12. THE WATER BLINKS OR PURSLANE GROUP.

In the order Portulaceæ are included, amongst British plants, Water Blinks and two species of *Claytonia*.

There are nearly 150 species and 17 genera, which are of universal distribution, but more characteristic of the American flora.

The group shows relationship with the Caryophyl-

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There are nearly 150 species and 17 genera, which are of universal distribution, but more characteristic of the American flora.

The group shows relationship with the Caryophyl-

laceæ and the Illecebraceæ, but the calyx with two to three sepals is distinctive. Here are included the Purslanes, often cultivated in the garden as salads and potherbs. The foreign types have frequently showy flowers.

They are mainly herbaceous annuals, but a few are shrubs. The plant is succulent, with fleshy leaves which are opposite, reduced in some cases to hairs in the axils.

The flowers are in cymes, regular and hermaphrodite. The calyx consists of two sepals united below, the lower overlapping the upper one. They are considered sometimes to be bracteoles. There are four or more petals which are distinct or united below, overlapping in bud. The stamens are five, free or adnate to the petals, with filiform anther-stalks opposite the petals, or indefinite. The disc is small or wanting.

The ovary is 1-celled, superior. There are three stigmas and two or many ovules. The style is short, simple, or trifid, and the branches are stigmatic throughout. The capsule opens transversely or is two- to three-valved, and is one-celled. The seeds are single or numerous. The embryo is round in section, curved, hooked or annular, with mealy albumen. The hilum is marginal.

The flowers secrete honey and are pollinated by insects, but in Water Blinks are sometimes cleistogamic.

The capsule is explosive in the last. In Water

FIG. 24.—FIELD MOUSE-EAR CHICKWEED (*Cerastium arvense*).
Messrs. Flatters and Garnett. *See page* 13

The Author. FIG. 25.—WATER BLINKS (*Montia fontana*). *See page* 137.

Blinks there are three stamens (or four), in *Claytonia* five. In the former the petals are united, in the latter they are distinct.

WATER BLINKS (*Montia fontana*).

So diminutive a plant is not likely to be observed except by the careful botanist who makes a thorough study of the vegetation of a district, hence it is not a well-known wild-flower. The first Latin name commemorates the Italian botanist J. de Monti. The second refers to its habitat in moist places (*fontana*, fountain, spring).

Water Blinks is found in all parts of the British Isles, as far north as the Shetlands, and in Ireland and the Channel Islands. In the Highlands it ascends to 3200 ft.

The habitat is brooks or marshes on the borders of rills and springs or moist places where the water is not stagnant. The plant also grows on wet heaths. There is one variety which grows in water, hence the name Water Blinks. It is also a member of the freshwater aquatic formation, growing in quickly flowing streams, with an association of plants in non-calcareous waters, with Bog Stitchwort, Ivy-leaved Crowfoot, Starwort, etc. In the Heather moor association it is found as a member of the rush society on upland moors, amongst arctic alpine vegetation in the pasture zone, and with an association of hydrophilous or aquatic crevice plants.

The habit is tufted, the plant being succulent, pale green, limp, branched, smooth—in water the stems are longer and weak. The stem is short, rigid, erect or more or less so. The leaves are spoon-shaped, not free at the base, more or less opposite.

The flowers are minute, white, drooping, then erect, solitary, or in small racemes of 2–3 flowers, in the axils of the upper leaves. The sepals are blunt. The petals are only slightly longer than the calyx. The capsule is small, globular, or inversely ovoid, the valves rolled longitudinally inwards after the seeds drop. The seeds are rather large, shining, with numerous, conical, acute tubercles, arranged in three lines following the curves of the seed, netted to rough, dull black.

The flowers are to be found between April and August. The plant is a herbaceous annual. It is from 1–3 in. in height.

The flowers are very inconspicuous, and little likely to be visited by insects, except creeping flies. The anthers and stigma ripen at the same time. As a rule, therefore, self-pollination occurs. In wet weather, and in the aquatic form, the flowers are cleistogamic.

The capsule opens by three valves, the seeds lying across the valves. The inner surfaces of the valves contract when dry and the seeds are shot to a distance.

The leaves have been eaten as a salad.

Blinking Chickweed, Blinks, Water Chickweed, Water Blinks are the names by which it is known.

MONTIA FONTANA.—*Here, in Fig.* 25, *the tufted habit is well shown, as well as the form and arrangement of the leaves, which are spoon-shaped. Flowers are seen in the axils of the leaves.*

13. THE MILKWORT GROUP.

In the order Polygalaceæ are included some seven hundred species, placed in ten genera, and almost, like the last group, cosmopolitan in range. They, however, do not apparently occur in New Zealand, Polynesia, or in the Arctic Zone. They are thus mainly southern or tropical. The Milkworts are the only European members of this group.

These plants are either herbaceous or shrubs, or small trees. The leaves of most of them are simple, entire, alternate, opposite or in whorls, and stipules are not, as a rule, present, and if so, thorny or scaly.

The flowers are very irregular, in terminal racemes, spikes, or panicles, and bracts and bracteoles are usually produced. The perianth is complete, with two whorls. The calyx is polysepalous, inferior, with five irregular or unequal sepals, the two inner alæ large and petaloid. The corolla consists of five, more usually three, petals, which are hypogynous, the lowest awl-like, and the upper two are more or less united to the staminal tube or filaments, the

median, anterior petal being keel-like, with a terminal brush. The flower is thus more or less papilionaceous, as in *Leguminosæ*.

The stamens are eight (or seven, five, four, or three), or in two bundles of five each, and hypogynous, united below into an open tube.

The anthers are one-celled, and open above by pores, there being four anthers to each stamen. There is a single style, with a single stigma, and the former is hooded at the tip. The stigma is oblique. The ovary is two-celled, with one ovule in each loculus as a rule. The fruit is a capsule, nut, or drupe.

The structure of the flower resembles that found in the Leguminosæ. The flower is a pollen-flower, the tenth stamen not being free. Pollen falls into the hollow in the style, and an insect in touching the stigma bears away pollen from the spoon, which it transfers to the stigma in the next flower. In the absence of insects the stigma bends over and dusts itself with pollen from the hollow of the style.

The capsule opens above, and the seeds may be dispersed by the wind.

Some of the members of this group are used in medicine for lung troubles and as sudorifics. The Snake-root of North America is well known. Some of the plants are reputed to possess remedies for snake-bites. Phatany-root is bitter in principle, and has been used to adulterate port-wine.

MILKWORT (*Polygala vulgaris*).

Formerly all regarded as constituting one species, there are now several distinct species of Milkwort which are recognised. The one under review is the most common. It is found in all parts of the British Isles, as far north as Shetland, and in the Channel Islands.

This is a typical heath plant, found on sandy commons, in upland meadows and pastures, and in peaty fens. The type of pasture it frequents is neutral grassland on a clayey or loamy soil, with Grassy Stitchwort, Purging Flax, Red and White Clover, Bird's Foot Trefoil, Tormentil, etc. Another habitat is the grass heath on sandy soil. It is also found on limestone and chalk pasture.

Wiry, and more or less prostrate in habit, the rootstock is woody and short, the stem having prostrate or ascending branches, which may flower the first year. The plant is smooth or rarely downy. The stems are numerous and leafy. The leaves are scattered, the lower ones crowded, smaller, oval or rounded, oblong, the upper linear to lance-shaped, alternate, rather leathery, and entire.

The flowers are extremely beautiful, variable in colour, usually blue, but also white, lilac, or purple, in terminal racemes, on short stalks with a small bract below. The three outer sepals are small, linear, green, the two wings twice as large, oblong and coloured. They turn green after the ovules are

inhabit deserts, sea-shores and steppes, and exhibit adaptations to dry conditions, with reduced leaf-surface, etc.

The group is related to the Pink group, the Purslane group and the Sea Heath group.

These plants are small trees, shrubs, or herbaceous plants. The leaves are alternate, small, scale-like, overlapping, clasping at the base, ericoid, without stipules. The flowers are either solitary or in racemes, or panicled in axillary spikes, without bracteoles. They are regular and hypogynous. The calyx consists of four or five sepals, which are overlapping in bud, and is persistent. There are five or four petals, inserted at the base of the calyx, distinct or united below. The stamens are as many as the petals or twice as many or indefinite, distinct or united by the stalks, inserted on the disc, and the anthers are versatile.

The disc is hypogynous or slightly perigynous, with ten honey-glands. The ovary is not attached to the calyx, and is one- or two- to five-celled.

There are two to five styles distinct or united at the base, or absent, in which case the stigmas (two to five) are sessile. There are few or numerous ovules. The capsule is two- to five-valved. The seeds are erect, winged or crowned with a tuft of hairs.

There is a Mediterranean species which yields a sugar-like substance, which is called Manna by the Arabs. As halophytes, several members of the

FIG. 26.—MILKWORT (*Polygala vulgaris*).

Messrs. Flatters and Garnett. *See page* 141.

Messrs. Flatters and Garnett. *See page* 145.

FIG. 27.—TAMARISK (*Tamarix gallica*).

Tamarisk group yield sulphate of soda when burnt. They also yield galls. There are some species that have astringent properties. Dyes are also afforded by some of the plants of this group. Medicinal properties are even attributed to some of the species.

TAMARISK (*Tamarix gallica*).

It is doubtful if this plant is a native of this country, for it is largely planted, and occurs on the south and east coasts of England and in the Channel Islands. It is frequent in the Mediterranean region, where it is maritime. It is also found on the Atlantic coast of France and Spain.

Where naturalised in England it grows on the coast, on sandy and marshy sea-shores. It forms a protection to the coast, serving the same purpose as Sea Buckthorn, Dwarf Willow, and the sand-binding grasses such as Marram and Lyme Grass. An evergreen shrub, the plant has a feathery appearance from the arrangement of the slender branches, which are leafy, erect, or slightly drooping at the tip. The leaves are very small, smooth, acute, closely overlapping, or pressed to the stem, scale-like, triangular, keeled, or spurred, auricled, narrowed below. The leaves on the older wood are larger and awl-like.

The flowers are small, pink, crowded, on an acutely five-angled disc, narrowed into the filaments, in axillary, blunt, catkin-like spikes, or forming branching, terminal panicles. The sepals are lance-shaped.

inner may be functionless. The anthers are versatile. The ovary is syncarpous, superior, multilocular, with as many cells as styles, which are simple, and open on maturity by the same number of valves. The ovules are numerous, on the inner angles of the cells. The stigma is pin-headed. The capsule is septifragal. The valves are concave or bent inwards, and separate from the axis and testa. The seeds are straight or curved, numerous, with frequently a wrinkled or rough testa or seed-coat. The cotyledons are very small.

The group is of no economic importance, but the plants are acrid.

The type described "six-stamened Waterpepper," has stalked flowers and three petals, with six stamens and a pistil, with three styles.

The other British species is called "eight-stamened Waterpepper," and has the parts in fours, with stalkless flowers, four petals, eight stamens, four styles.

Both are of local occurrence in Britain.

WATERWORT (*Elatine hexandra*).

Like Water Blinks, this plant is probably much overlooked, though it is nowhere a common plant, and may be described as rare. The second Latin name, *hexandra*, refers to the number of stamens (six), in which it differs from *E. Hydropiper*, in which there are eight, with four petals and styles, whereas there are three petals and three styles in this species.

Thus, within one genus there are two species, one of which has the floral characteristics, numerically, of Dicotyledons, with parts in fours, the other of Monocotyledons, with parts in threes, as here.

Waterwort is found in many parts of Scotland and England, chiefly in the west, but also in the eastern counties. It ascends to a high altitude in the Highlands, and occurs in N. and W. Ireland.

One may find this plant by the borders of ponds and lakes. It occurs in the freshwater aquatic formation in water which is relatively rich in mineral salts, in nearly stagnant water, being a submerged plant. On upland moors in the Pennines it has been found in hill peat in peat beds with White Birch, Alder, etc., in a forest bed with large stools of the foregoing trees, and at 2450 ft. in Teesdale and Tynedale.

As an aquatic plant the habit is matted or tufted, the stems limp, rooting at the nodes, creeping, small. The leaves are small, spoon-shaped, inversely ovoid, or oblong, tapered at the base, opposite, longer than the stalk.

The flowers are minute, globular, stalked, with the parts in threes, rose-coloured, alternate, in the axils. The calyx is divided into three nearly to the base. The three petals are inversely ovate, not much longer than the unequal sepals. There are six stamens. The capsule is top-shaped, three-celled, membranous, the septa evanescent after bursting or adherent to

The seeds are eight to twelve, straight, ascending, numerous, ribbed and furrowed transversely.

The flowers open between July and September. The plant is a herbaceous annual. It is a creeping plant.

As an aquatic plant with flowers frequently submerged, the flowers are probably largely cleistogamic, being small and axillary.

The capsule opens when ripe, and the seeds are dispersed in the water.

The plant has acrid properties.

ELATINE HEXANDRA.—*The habit of Waterwort is well shown in the illustration, Fig. 28, the plant being aquatic, and more or less streaming in habit. Fruit is shown in the centre.*

15. THE ST. JOHN'S WORT GROUP.

The order Hypericaceæ has been placed by Engler in the Guttiferæ, including a few foreign types, with about four hundred and fifty species and forty-two genera. They are mainly tropical, and these embrace types which differ in the number of parts in the flower, the arrangement of stamens, or the seeds. Some of these are tall shrubs or trees. In the order Hypericaceæ the numerous stamens in three or five bundles are a characteristic feature.

In Britain the only representative is the genus *Hypericum*, found in South Europe, West Asia, and North America.

The Author. FIG. 28.—WATERWORT (*Elatine hexandra*). *See page* 148.

The Author. FIG. 29.—HAIRY ST. JOHN'S WORT (*Hypericum hirsutum*). *See page* 152.

The plants are herbaceous perennials. The leaves are simple, entire, opposite, without stipules.

There are oil glands or ducts, and translucent dots, on the leaves. Some are pellucid and transparent, others black, usually on the underside of the leaves, on the margin, and on the flowers. This is a very characteristic feature.

The flowers are regular, yellow, terminal, cymose, or in umbels, rarely in the axils. Bracteoles are placed just under the calyx, and resemble the sepals. The flowers are hermaphrodite and hypogynous. The calyx is polysepalous, inferior, overlapping, with five sepals, rarely four, not falling. The corolla is polypetalous, with five petals, usually oblique, and twisted in the bud, bordered with black dots.

The stamens are numerous or indefinite, polyadelphous, more or less united in bundles of three or five, due to branching of the originally simple papillæ, and hypogynous. The anthers are versatile. The pistil is syncarpous, with numerous, few (or a single) ovules, and an ovary of three to five carpels, one- or three- to five-celled. The styles are of the same number, free or united. The fruit is often a capsule, many-celled with several valves, septicidal, a drupe or berry in some cases. The valves curve inwards. There is no albumen in the seeds, which are small and numerous.

There is no honey, but owing to the abundant pollen the flowers are much visited by insects. The flowers are also very conspicuous, as in Rose of Sharon.

The seeds are dispersed by the wind. Several of these plants are favourite garden flowers, as Tutsan, Rose of Sharon, etc.

A large number have aromatic or resinous properties. A yellow resinous juice used in medicine is yielded by some of the plants. The Hypericaceæ have astringent, tonic, and other properties, but the fabulous remedies, such as the healing of wounds, etc. (hence Tutsan, or *tout saine*), are no longer treated seriously, being based, as a large number of the so-called medicinal properties, upon the doctrine of signatures, a principle which has not rendered medicine any service, and rather tended towards the present state of stagnation, so far as medicinal herbs are concerned.

HAIRY ST. JOHN'S WORT (*Hypericum hirsutum*).

Like other St. John's Worts this species is a pretty wild flower, with golden blooms, not quite so brilliant as those of the Perforate St. John's Wort, nor tinged with red as in the Pretty St. John's Wort, but numerous, and giving a charming effect.

This species is a common one throughout the British Isles, easily distinguished by its very hairy stem and leaves and the duller green colour. It is found in all parts of England and Wales, Scotland and Ireland, but is rare in the last, and ascends to 1300 ft. in Yorkshire.

Hairy St. John's Wort is found in woods and copses, in damp oak woods, on clays and loams. It

also occurs on limestone in the dry parts of ash woods where the ground is stony, on limestone scrub, and in limestone grassland associations. Where the soil is a marl or calcareous sandstone it also occurs in Ash-Oakwood, with Dog's Mercury, etc. By the wayside it is a frequent plant, forming tall, compact tufts.

The habit is erect. The stem is round, leafy, more or less simple, finely downy, the pubescence curly. The leaves have no glands at the margin, and are blunt, ovate, oblong, elliptical, borne on short stalks, narrowed at the base, hairy on the veins below, with numerous, pellucid, or nearly transparent dots.

The flowers are pale yellow, in axillary and terminal, forked panicles. The sepals are lance-shaped, linear to oblong, more or less acute, narrow, fringed with shortly-stalked glands. The petals are twice as long as the sepals, linear to oblong, with stalked glands. The styles are deciduous. The capsule opens by septa, and the seeds are oblong.

Hairy St. John's Wort flowers in July and August. It is a herbaceous perennial. The height is from 1–3 ft., or usually about 2 ft.

The floral mechanism is like that of Perforate St. John's Wort. The flowers are not so large, however, and the stamens are not so numerous—seven to nine in a bundle. The flowers are less numerous or crowded, and the number of insect visitors is fewer. The stamens are in isolated bundles, and do not take up so much room, so that the

three styles do not touch them when the flower is open, being longer. When the flower is closed the anthers touch the stigmas, and self-pollination results, and appears to be quite effective.

When the capsule is ripe and opens the seeds may be jerked out by the wind.

St. John's Wort was called *Fuga dæmonum*, and considered efficacious in driving away evil spirits, being hung up over doorways for this object.

This species is not the particular one around which so much folk-lore clusters. But St. John's Wort was associated formerly with healing properties, being astringent, and used to decorate churches on St. John's Day (Midsummer Eve), and it was regarded as a charm against storms. The St. John's Worts were formerly employed as medicines. Steeped in oil of turpentine the plant yields a red varnish. The plant boiled in alum yields a yellow dye for wool, having a yellow resinous juice, as in the gamboge tree.

HYPERICUM HIRSUTUM.—*Note the hairy character of the plant, and the glandular nature of the inflorescence. The exserted stamens can be seen in many of the flowers* (*Fig.* 29).

16. THE MALLOW GROUP.

The order Malvaceæ includes the Marsh-mallow, the Mallows, and Tree-mallow amongst British plants. As a type, the Dwarf Mallow is selected for description.

There are about seven hundred species and thirty-five or more genera in this group, which are found in Temperate and Tropical countries.

Two groups are recognised, one in which the carpels are in vertical rows, *e.g. Malope*, often cultivated as a garden plant, the other in which they are in one plane. To the last belongs the Mallow group, with as many styles as carpels, including, in addition to the British types, *Abutilon* and *Anoda;* the Ureneæ, with twice as many styles as carpels, including *Urena, Goethea,* and *Pavonia;* and the Hibisceæ, with capsular fruits (the two former having schizocarps), including *Hibiscus* and *Gossypium*, the Cotton plant. The Hollyhock is a well-known garden flower.

These plants are herbaceous, or shrubs or trees. The leaves are alternate and possess deciduous stipules, except the Tree-mallow, in the Malvaceæ, with three or more nerves at the base, with stellate or branching hairs.

The flowers are either solitary or in compound cymes. They are regular and hermaphrodite. The parts are usually in fives. There is an epicalyx in some cases, that is, a bundle of bracteoles; or it may be of a stipular nature. The calyx is inferior and gamosepalous with five sepals, and valvate in bud, with an epicalyx of three or more bracteoles united at the base. The petals are asymmetrical and five in number, and adnate to the base of the column, twisted in bud, sometimes oblique. There are many monadelphous stamens, which are hypogynous and

combined into a column or tube united to the petals, made up of the united anther-stalks. The anthers are annular or twisted, one-celled, and each equals half an anther. The pollen-grains are spiny. They open outwards. The disc is small; the pistil is syncarpous. There are several stigmas. The ovary is multilocular, and the carpels are numerous, in whorls, distinct or united. The fruit consists of numerous, dry, indehiscent, or two-valved loculicidal carpels, one- (or more) seeded. The seeds are sometimes woolly.

The group includes the Cotton plant, and all the Malvaceæ are mucilaginous and yield textile fibres, the bark in some, the cottony fruits in others. Some, as Marsh-mallow, are used medicinally. A large number are garden favourites. None of the plants are poisonous.

Dwarf Mallow (*Malva rotundifolia*).

A common wayside plant, often to be found on grassy banks at the base of a wall in a village, Dwarf Mallow is familiar to most of us.

A well-marked character, the rounded leaves, is indicated by *rotundifolia*. The plant is also dwarf, compared with the tall bushy Common Mallow, and this character is well shown in the illustration. Dwarf Mallow is found in all parts of the British Isles and the Channel Islands. It is not so common in Scotland and Ireland.

Mallows generally are roadside plants, or viaticals,

as Watson termed them. This plant is also found in waste places, and is a frequenter of stackyards and similar places associated with the activities of man and the cultivation of crops.

Dwarf in stature, the habit of this species is prostrate, the stems ascending at the end.

The stems are hard and woody below, downy to the touch, numerous. The leaves are kidney-shaped, round, with five to seven, shallow, short, broad lobes, scalloped, or coarsely toothed, on long stalks, heart-shaped at the base. The stipules are ovate, acute.

The flowers are small, pale lilac, white or purple, in clusters, in the leaf-axils, borne on short stalks bent back in the fruiting-stage. The outer sepals are linear to lance-shaped, not so long as the inner ones. The latter are ovate, acuminate, stellately hairy. The petals are two to three times as long as the calyx. The carpels are smooth, not netted, and indefinite, or about fifteen in number, round on the back, together forming a disc-like fruit, furrowed at the junction of two contiguous carpels.

The Dwarf Mallow flowers from June right up till September. It is a herbaceous perennial. It is usually more or less prostrate, rising not more than 6 in. above the ground. But it grows to a height of 18 in. when, as is rarely the case, it is erect.

The flowers are not so large as in the Common Mallow, but the mode of pollination is largely the same in both cases. The anthers and stigma ripen

together. Honey is secreted in five pits in the receptacle between the base of the petals, covered with hairs which protect it from rain and short-lipped insects. When an insect visits a younger flower for honey, it rubs pollen off the anthers, and at a visit to an older flower deposits it on the stigma. The stamens are erect at first in the centre, and remain more or less so, so that when the papillate stigmas ripen they curl over and touch the latter, curling in amongst the stamens, and self-pollination is the natural result. Few insects visit the flowers, and they suck the honey from outside when the flowers are closed.

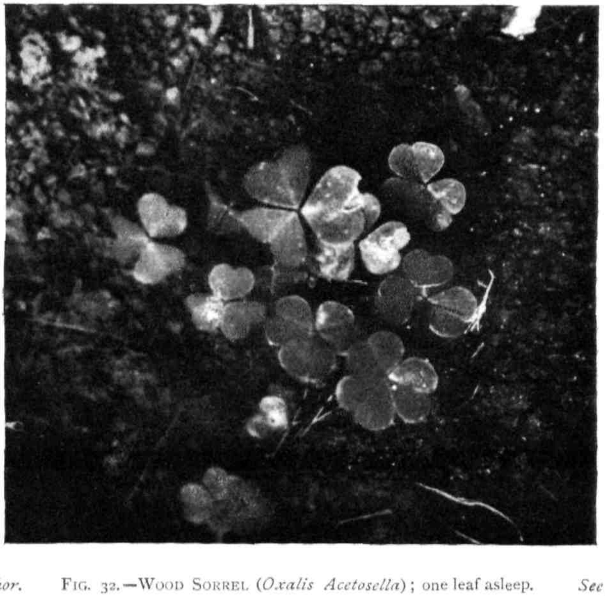
The fruit is a schizocarp, the carpels one-seeded, splitting apart when ripe and falling near the plant. The fruits are called cheeses by children and used to play a game.

Cheese, Doll-cheeses, Dutch Cheese, Fairy Cheeses, all show the frequent connection between the above game and this plant in different parts. Other names are Dwarf Mallow and Pellas.

The name Mallow comes from the Anglo-Saxon Malwe, and in Latin is Malva, the Greek Malache, meaning soft, in allusion to the relaxing power of the plant.

MALVA ROTUNDIFOLIA.—*The whole character of the plant is well illustrated in Fig.* 30, *the rounded, six- to seven-lobed leaves, the small flowers with notched and veined petals arising in the axils, with the characteristic calyx, being well figured.*

V. E. Mayes. FIG. 30.—ROUND-LEAVED MALLOW (*Malva rotundifolia*). *See page* 156.



The Author. FIG. 32.—WOOD SORREL (*Oxalis Acetosella*); one leaf asleep. *See page* 168.

17. The Lime Group (Summary).

(*Introductory Volume, p. 70.*)

As a type of the Order Tiliaceæ, which in the British Isles is represented by three species (only one of which—the Small-leaved Lime—is regarded as truly native), the Common Linden, a much-planted tree, was described (*loc. cit.*).

The order consists of some three hundred and eighty species and thirty-five genera. The Limes and their allies are found in theTemperate and Tropical regions, especially Asia and Brazil. From the Mallow group, to which it is closely related, this order differs in the petals overlapping in bud, not being twisted, the free or united stamens (sometimes in bundles), the two-celled anthers, and the carpels united into a many-celled ovary.

Mainly Trees or Shrubs, a few are herbaceous plants. The leaves are alternate, entire or toothed, with deciduous stipules in two ranks. The leaf may be asymmetrical and twisted. The terminal bud does not develop the next year.

The flowers are in axillary, corymbose cymes, with a flowerstalk enlarged into a membranous bract, and are usually complete, regular, with the parts in fives or fours. The calyx is polysepalous, inferior, with five sepals, distinct or united below, valvate in bud. The corolla is polypetalous, with five petals, or apetalous, with sometimes a small gland at the base.

The stamens are indefinite, numerous, hypogynous, inserted on the tumid disk, at the base of the petals, or on an androphore, with slender anther-stalks, distinct or united into three or five bundles. The anthers are two-celled, and open by pores or valves. The pistil is syncarpous, the ovary is globular, two- to ten-celled, two ovules in each cell, the carpels united or distinct. The style is single, and there are as many stigmas as carpels, the stigma being five-toothed, pin-headed, or lobed. The fruit is a small, dry nut, globular, with one or two seeds. It may be loculicidal or indehiscent. The seeds are albuminous.

The flowers contain honey secreted by the sepals, an unusual feature, and the anthers ripen first.

The order is related to Sterculiaceæ and Malvaceæ, or to the Theaceæ.

The Lime group contains many plants of economic importance, such as timber trees. They yield a mucilaginous juice, and fibre or bast of remarkable length and durability. Jute is derived from *Corchorus olitorius*, a native of India. This is obtained by steeping the stems in water, as in the case of Flax. Fishing lines and nets are made from it. In Egypt the leaves are used as a potherb. Mats are made from the bast in Russia. Some of the members of the Lime group produce berries. The seeds of others are bony and set in jewellery as ornaments.

18. THE FLAX GROUP.

The Common Flax has been selected as a type of the Order Linaceæ. Four species of Flax are found in the British Isles, and also All-seed, or *Radiola*, which differs from Flax in having the parts of the flowers in fours, not in fives.

Of this order about one hundred and twenty species have been recognised, placed in nine genera. In distribution they are more or less cosmopolitan. The Flax group shows affinity with the Mallow and Geranium groups, and also with the foreign groups, Malpighiaceæ and Ternstroemiaceæ. From the Geranium group it is distinguished by the foliage and absence of a carpophore, and from the Pink group, which it resembles in habit, by the pin-headed stigma and fruit.

The Flax group consists of herbaceous plants, undershrubs or trees. The leaves are alternate, nearly opposite, simple, entire, without stipules as a rule.

The flowers are regular and hermaphrodite, the inflorescence cymose. The parts are usually in fives. The calyx is polysepalous, inferior, with four or five sepals, quincuncially arranged, distinct, or rarely united below, persistent, overlapping in bud. The corolla is polypetalous with four or five petals, twisted in the bud or overlapping, soon falling. The stamens are five, or twice as many, or more, alternate with the petals. Some staminodes, or functionless

stamens, may be found between them, and the stamens are united in a ring by their base, or they may be free. They are hypogynous. The anthers are versatile. There is no disc, or one made up of five honey-glands. The ovary is three- to five-celled, with as many styles. There are one or two ovules in each loculus. The ovary may be incompletely divided, into twice as many cells as styles, by a nearly complete partition. The stigmas are terminal. The capsule is globular and septicidal, or a drupe. There is no central column. The carpels open inwards by slits lengthwise. The seeds are mucilaginous, compressed. The embryo is long and straight.

The flowers contain concealed honey. The anthers and stigma ripen simultaneously. The flowers are dimorphous or trimorphous. Sometimes the flowers close at night and in rainy weather.

The capsule opens by ten slits and the seeds are wind-dispersed.

Flax is one of the most valuable products in the vegetable kingdom, and has been cultivated from early times for the bast fibres of the stems. The seeds yield an oil—linseed. The refuse is used for oil-cake.

The flax plants are pulled up entire, dried in the sun, and the stems are then steeped in water till the fibres are, by fermentation, separated from the rest of the plant.

FLAX (*Linum usitatissimum*).

One of the most ancient cultivated plants, Flax was known to the people in the Stone Age, and remains of it have been found in pile-dwellings in Switzerland. Biblical history assures us of the use of it in early days in Egypt. Yarn was one of the imports from Egypt in Solomon's day. Linen was imported to Greece from Egypt according to Herodotus. Egyptian mummies are swathed in linen similar to modern fabrics. That wonderful race the Egyptians were proficient in textile industries like all else. A writer states that Herodotus records that "in the temple of Minerva at Lindus in Rhodes there was deposited a curiously wrought linen corselet, which had belonged to Amasis, King of Egypt, who lived about 600 years before Christ. Each thread of the corselet was composed of 360 filaments, and it was ornamented with cotton and gold. Some remains of this curiosity were still to be seen in the time of Pliny, who relates that those who beheld it wishing to assure themselves of the truth of the fact had by degrees reduced it to a very small relic. At the period in which Pliny wrote flax was well known and extensively cultivated, not only in Egypt, but in several parts of Europe. It was in all probability known in Greece, and even cultivated there, many ages before Pliny."

In this country flax is an introduction. It is not a very common plant, but occurs here and there as

an escape from flax-fields, being cultivated in Ireland and formerly in Great Britain, as the remains of many old steeping pits serve to show. The Romans introduced it into this country.

The habitat is waste places, where Flax may be found along with other plants of a similar character, such as Hemp.

The habit is grass-like. The stems are solitary, tall and erect, quite devoid of hair, branched above only. The leaves are alternate, linear to lance-shaped, erect, narrow, acute, entire.

The flowers are rich blue, in broad cymes or sympodial cincinni, loosely corymbose above. The sepals are inversely ovate, lance-shaped, acute, fringed with hairs, three-nerved. The petals are scalloped at the margin of the limb, and are inversely ovate. The capsule is globular or slightly flattened, hairless within.

The flowers bloom in July, August, and September. Flax is a herbaceous annual, which varies from 1–2 ft. in height.

The flowers are much larger than in the Purging Flax, but have a similar mechanism. The five anther-stalks are adherent to the fleshy ring at the base of the ovary, which secretes honey in five glands above, flat and small, and opposite the stamens. The drops increase in size, and extend to the sepals. The petals are attached just above the honey-glands and alternate with the stamens. The petals do not touch just above the glands.

The five anthers ripen when the stigmas do, and

are level with them, but distant at first from the latter, so that self-pollination does not happen if an insect visits the flower and inserts its proboscis between stigma and stamens, as this leads to cross-pollination. If it, however, inserts its proboscis outside the anthers they are pressed against the stigma, and self-pollination ensues. This occurs also in the absence of insects, and seems to be effective. Bees, Humble-bees, the Silver Y Moth visit it. Many of the other species of Flax are heterostylic or dimorphic, with long- and short-styled flowers.

When ripe, the capsule opens and the seeds fall out. The seed-coat is mucilaginous, and this affixes the seeds to the ground.

Flax is derived from the fibre, and obtained by rotting or retting the soft tissues in water. The seeds or linseed yield an oil by pressure, and cake, which is the refuse, is used as a cattle food. The fibre is derived from the inner bark, called the pericycle, bast, or phloem, consisting of long cylindrical tubes pointed each end, 20–40 mm. long, with a flexible wall, which imparts to it an elasticity. Cordage is made from it, and the fibres are as strong as iron. The seeds are purgative. The tow was used for wicks in lamps. The oil is drying oil, and used in oil-painting.

Linum is from the Greek linon. Flax is from the German flachs, the Latin is *filare*, to spin, and *filum*, a thread.

Flax is also called Lint Bells, Lint Bennels, Blaebows, Flax, Flix, Lin, Line, Lint, Lint-bow, Vlix.

A bride in Germany was expected to put flax in her shoes that she might never come to poverty. Elsewhere it was customary to tie a string of flax round the left leg in order to enjoy the full blessings of marriage. The blue flowers are connected with blue eyes or blue skies, and the plant thus called Spring wort.

LINUM USITATISSUMUM.—*In Fig. 31 the flax habit is well shown, also the large flowers, the rounded capsules, and persistent calyx.*

19. THE GERANIUM GROUP (SUMMARY).

(*Introductory Volume, p. 74.*)

In the order Geraniaceæ are included some of the most beautiful plants in the world, and nearly every cottager delights to cultivate the Pelargonia or so-called Geraniums, which grow so luxuriantly in the window-case, almost invariably the admiration of the passer-by.

The Woodsorrel and Balsam groups have been included in this order by Bentham and Hooker.

Of the order Geraniaceæ there are over 400 species, placed in 11 genera. They are of cosmopolitan distribution, but the Pelargonia are mainly derived from the Cape of Good Hope, the true

FIG. 31.—FLAX (*Linum usitatissimum*).

Messrs. Flatters and Garnett. *See page* 163.

Geraniums and Stork's Bills being natives of Europe, North America, and North Asia.

Mostly herbaceous, rarely fleshy or succulent, these plants have swollen or tumid stem-joints and broad membranous stipules. A few are shrubs. Some are annual, most are perennial in duration. The leaves are opposite, or alternate, compound, and much divided, toothed.

The flowers are generally regular and hermaphrodite, the parts in fives. The calyx consists of five ribbed sepals, which are distinct, overlapping, with the tips valvate, and persistent. The petals are clawed, five in number, overlapping or twisted in the bud. There are ten stamens, or three times as many as the petals, or as many, in two whorls, the outer opposite the petals, that is, obdiplostemonous, if there is more than one whorl, and hypogynous. In the Stork's Bill there are staminodes. The pistil is syncarpous, superior, made up of five carpels, or two to three, or three to five arranged round the characteristic torus or beak, which gives the group its name. The ovary is five-lobed and five-celled, with one or more seeds in each, attached to the central axis. The five styles are long, united with five stigmas. The fruit is a schizocarp as a rule, the carpels or the seeds becoming detached from the persistent style. The carpels are detached with their awn, which is hygroscopic.

In the species with large flowers the anthers ripen first, the inner stamens opening first. Honey is

secreted in five glands at the base of the inner stamens to which honey-guides on the petals converge. The claws of the petals are hairy, to protect the honey from rain and creeping insects. In the other small-flowered types the stigma is ripe first.

The seeds or carpels are jerked to a distance by a catapult mechanism.

The group includes numerous showy plants which are familiar garden flowers. Many are aromatic and astringent, and yield volatile oils.

Wood Sorrel (*Oxalis Acetosella*).

Some plants have the faculty of sleeping, and exhibit sleep movements, or *nyctitropic* movements, as they are called. These movements are related to the variation in the intensity of light due to the alternation of day and night. At night the leaves, fully expanded in the day, close up, and the edges are turned upwards, and in the case of compound leaves the leaflets close up.

This is due to a change in the turgidity of the parenchymatous cells. The effect of the sleep movements is to prevent loss of water by transpiration, and to protect the plants from cold, which checks absorption.

In the Wood Sorrel there are four types of movement. The whole leaf moves, changes its position, the chlorophyll granules in the leaf change their position, and the granules change their form. A

similar effect to that caused by nightfall is manifested in intense light, the leaves assuming a vertical position, so that the light rays fall less directly upon them. Plants whose leaves are horizontal suffer more from frost than those the leaves of which are vertical.

It is the chemical rays that cause the movement. There are motile organs in the short stalk of the leaflets which assist the movement. Leaves from which light is excluded during the day still open their leaflets. When yellow, orange or red rays are shut out the plants behave as under white light. When the violet and blue rays are excluded and only red light present, the plant acts as if it were in the dark.

The cells are normally turgid, the sap being enclosed by the cell-wall and lining of protoplasm. When the latter is stimulated to change its characteristics and allow water to escape, the sleep movement is possible. In the leaf tissue are three layers. The upper layer comprises blunt cones, the two lower have stellate cells with inter-cellular spaces. In daylight the chorophyll bodies are arranged to receive as much light as possible. When the light is too intense they collect along the cell-walls, parallel with the rays, so that they receive less light, and collect in groups at the cell corners if the light continues to be intense.

Wood Sorrel is a common plant in the British Isles as far as the Orkneys, and occurs in Ireland and the

Channel Islands. It ascends to 4000 ft. in the Highlands.

As the English name implies, Wood Sorrel is a woodland plant which is found in moist, shady places, woods and copses. It occurs in damp oak-woods on clays and loams, in the sandy oak-wood and oak-birch-heath association, on sandy soils, in the pine-wood association, on siliceous soils in the sandy oak-wood association, amongst bracken on siliceous grass-lands, in damp ash-woods on limestone, on limestone pavements, as they are called, on the Pennines, in arctic alpine grass-land, in corries in the arctic alpine zone, and in fissures in the shade at the same elevations.

Wood Sorrel is a stemless plant. The habit is like that of rosette or bulbous plants with all the leaves radical. The root-stock is creeping, slender, knotted, toothed and scaly. The leaves have each three leaflets, the leaf-stalk long, the leaflets hairy, inversely heart-shaped or ovate, delicate green, rather acid in taste (hence *oxalis* and *acetosella*), containing binoxalate of potash. The stipules are broad and membranous.

The flowers are solitary, borne on scapes or flower-stalks, in the axils. The stalks are long and slender, with two scaly bracts in the middle, and the flowers are white, with purple veins. The sepals are small, oblong or ovate, blunt and thin. The petals are inversely ovate, notched, meeting above the claw. The corolla is four times as long as the calyx. The

capsule is ovoid, five-angled, erect. The seeds are two or three in each cell, shining, black-ribbed longitudinally.

Wood Sorrel blooms between May and August. It is a herbaceous perennial. Rarely six inches in height, it is more often about three.

Honey is secreted in five fleshy knobs at the base of the petals. The flowers open between nine a.m. and six p.m. The style varies in length, and the plant is dimorphic. The stalk bends downwards when the flower fades, and the head is concealed amongst the leaves (as in *Adoxa*). When the seeds are ripe it becomes erect again and the capsule may be seen above the leaves. Experience differs as to the degree of dichogamy. In some cases the flowers are proterandrous, the anthers ripening first, in others the anthers ripen with the stigma. The stalks bend over in wet weather. The flowers are large in the dimorphic flowers, and other smaller types are cleistogamic when the flowers bury the seeds underground. There are few insect visitors.

The capsule opens by loculi, and is five-chambered. The seeds are attached to a central pillar. Each seed has a fleshy aril at the base. The cells of the inner layers when ripe are very turgid, and the aril turns inside out, so that the seed is shot to a distance. The capsule is thin-walled opposite the middle of each chamber. Each outer coat of four or five layers of cells of the seed is transparent, with a smooth, hard, black testa within. In the inner

layer the cells are not so large, closely compressed, and turgid. The coat splits on one side, the inner cells expand, so that the coat turns inside out, the inner layer coming to the outside, the outer to the inside.

Wood Sorrel is called also Wood Sour from its acid taste.

The plant is so familiar to most country dwellers that it has a large number of names—Alleluia, Bird's Bread-and-Cheese, Cuckoo Bread, Cuckoo-meat, Green-sauce, Gowk Meat, Laverocks, Lujula, Rabbit-meat, Shamrock, etc.

In country places children call the Wood Sorrel Bread and Cheese or Cuckoo's Meat; in Latin it is *Panis cuculi*, in French Pain de coucou. In Devonshire it is called Cuckoo's Sorrel or Cuckoo's Bread. In Wales the flower is called Fairy Bells, used, so it was held, by the tiny folk, to call them to "moonlight dance and revelry."

Wood Sorrel was connected in the days of superstition with fairies. The plant is the Shamrock of St. Patrick, if there be any particular plant that can be so called, as the emblem of the Trinity is just as well illustrated by many trefoils.

When the juice is pressed out and evaporated crystals are formed. These constitute salts of lemon. The plant is poisonous, but has been used as a salad.

The staining of the petals with pink lines (honey-guides) led to the idea that they were stains of blood,

and that the plant grew near the Cross. By Italian painters—Fra Angelico, for instance—it is placed in the foreground of pictures representing the Crucifixion.

There is a species of Wood Sorrel which closes up its leaves before a storm, unfolding them when it is calm, and is utilised by husbandmen as a weather plant.

By doctrine of signatures, the leaves of the Wood Sorrel being heart-shaped the plant was used as a cordial.

OXALIS ACETOSELLA.—*The figure* (32) *of this plant shows the trifoliate leaves, with one leaf closing up and others ready to do so, whilst some have the leaflets horizontal as in the day.*

SMALL YELLOW BALSAM (*Impatiens parviflora*).

A Siberian plant, the Small Yellow Balsam has lately become fairly frequent in this country. It is characterised, as the name *parviflora* indicates, by the small flowers, as compared with the more native Touch-me-not (hence *Impatiens*). The latter name refers to the character which the capsules possess of exhibiting an explosive movement when touched.

The Small-flowered Balsam is found in various parts of England, being more or less naturalised.

I have found it growing freely and permanently on tan in a woodyard. It may be found in woods and waste places.

The habit is erect. The stem is smooth, shining, rather succulent. The leaves are elliptic to ovate,

with a long narrow point, and coarsely toothed, acute both ends.

The flowers are small, pale yellow, on erect stalks, bearing three to ten flowers. The posterior sepal is narrowed into a short straight spur.

The flowers are to be found between July and September. The plant is a herbaceous annual. It is from 1–2 ft. in height.

Many of the Balsams exhibit cleistogamic flowers, but they do not occur in this species. Self-pollination, however, is said to occur. Both sepals and petals are coloured. They are made up of six segments, three sepals and three petals, two outer opposite sepals which are flat and oblique. The upper sepal, which owing to the twisting of the stalk is lowest, is hooded and large, and ends in a conical spur below. The lower petal, owing to the twisting of the stalk, becomes uppermost, is symmetrical, small, but broad and rather hollow. The inner petals are oblique and irregular, unequally two-lobed. The five stamens cohere in a mass round the pistil, and the stalks are very short. The stigmas are very small, without styles or more or less stalkless. In bud the flowers are above the leaves, which are folded and stand around them. When they open the stalk lengthens and bends under the leaves. As the leaves flatten out they keep the flowers horizontal, forming a roof and rain falls off them. The anthers ripen first. Honey lies concealed in the spur. An insect visitor first touches the ripe crowded anthers

at the top of the flower. And when the stigma ripens bees may cross-pollinate the flower with pollen from a previous flower.

The fruit is a capsule with a fleshy pericarp, five-chambered. The dehiscence is septifragal. The walls are thin, and separate from the centre. The cells just below the epidermis become more turgid and tense than those in the lower layers. The carpels are turned somewhat to the right, and so like a cork-screw. The fruit bursts, and the valves, being elastic, roll up violently like a spring, inwards, starting from the base, and are shot to a distance, bearing the seeds with them, doing so at the least touch.

A kind of Balsam is called in Canton Fung Sin Fa or Phœnix Fairy flower. The Balsam is emblematic of Impatience, especially the one called Touch-me-not, and has been called also Quick-in-hand, from the fact that the fruit will burst if touched.

IMPATIENS PARVIFLORA.—*Note in the figure* (33) *the foliage, and the long peduncles with the long but small capsules, and small flowers distinguishing the present species from I. noli-me-tangere.*

20. THE HOLLY GROUP (SUMMARY).

(*Introductory Volume, p. 78.*)

The Order Aquifoliaceæ includes only one species in the British Isles, the Holly, which was described in the Introductory Volume. The name Ilicineæ

has also been applied to it. It has been included in the Corollifloræ or Gamopetalæ by some authorities and placed between the Heath Group and the Ash Group. The Hollies are related to the Spindle Wood Group, but the corolla is monopetalous with stamens at the base, and no disc.

There are nearly two hundred species arranged in five genera. Most of them are natives of America.

Most of these plants are shrubs or trees, often evergreen. The leaves are alternate, leathery, simple, often spinose. The stipules are exceedingly small, or absent altogether.

The inflorescence is cymose, often axillary. The flowers are regular, unisexual, often polygamous. The parts are in threes or more. There is no disc. The calyx is gamosepalous, with three to six sepals, usually four, overlapping in bud, and persistent.

The corolla is monopetalous below, and the four petals are united at the base, or distinct, deciduous, overlapping in the bud. The stamens are four, or four to six, inserted on the base of the petals, alternating with them. They are hypogynous. The anther-stalks are erect, slender, awl-like, with oblong two-celled anthers, opening lengthways. The ovary is three- to six-celled, sessile, fleshy. The style is short or absent, with terminal stigmas. The fruit is a drupe, wlth three or more stones, one-seeded, distinct, or united below, and indehiscent.

The seeds are hard and bony, with a membranous seed-coat, and possess endosperm.

The Author. FIG. 33.—SMALL YELLOW BALSAM (*Impatiens parviflora*). *See page* 173.

FIG. 34.—CROWBERRY (*Empetrum nigrum*).

Messrs. Flatters and Garnett. *See page* 179.

The honey is not abundant, but lies exposed. The plant is usually diœcious, but not invariably or completely so. There is sometimes a rudiment of a pistil in the male flowers. The female flowers are the larger.

The fruit is dispersed by birds.

In this group are included many plants having the theine principle which are used as a substitute for tea, or maté, *e.g. I. paraguayensis*.

The Holly is a useful tree, yielding timber for inlay work, and other products, besides serving as a hedgerow plant. There are some species that possess astringent and antiseptic properties, or are emetic. Holly berries are really somewhat poisonous.

21. The Crowberry Group.

A good deal of uncertainty has prevailed as to the proper position of the order Empetraceæ, which is represented in the British flora by one species. In the system of Bentham and Hooker it is placed last in the Thalamifloræ between the Holly group and the first group of the Calycifloræ, or Spindle Wood group. In their later handbook, however, they place it near the Euphorbiaceæ in the Apetalæ or Monochlamydeæ, but the seeds are erect and the ovules differ. Others place the order next to the Heath group in the Gamopetalæ. By some it is placed last in the Dicotyledons, after the Willow group. The nearest relationship seems to be with the

Box group, or the Spindle Wood group or Spurge group.

There are four species and three genera—*Corema, Empetrum, Ceratiola.* These plants are found in the Northern Hemisphere, and in the Andine region.

The habit is heath-like, and the plants grow in the same sort of habitat and have adaptations to the same dry conditions. But these adaptations are largely vegetative, and the floral structure is not like that of the Heaths. The plants are shrubs, and evergreen.

The leaves are bent over below, forming a cavity, into which the stomata open, and are leathery, alternate, without stipules.

The flowers are in racemes; the plants may be diœcious or polygamous. They are solitary or in the axils, on short shoots. They are regular, and there is a perianth of six scales in two rows, with six bracts, similar but smaller. There are three sepals or bracts which are distinct, leathery, overlapping in bud. There are two to three petals or sepals, hypogynous, distinct, not falling. The stamens are three, alternate with the petals, hypogynous. The filaments are long, slender, persistent. The anthers are two-celled, deciduous. The pollen is compound.

The ovary is rounded, three- to nine-celled. The styles are short, with awl-like or swollen stigmas, which are rayed. The fruit is a drupe with two to nine stones, which are one-seeded. The seeds are erect, with a very thin seed-coat.

The flowers are probably pollinated largely by the wind, but they may be entomophilous also, as the flowers contain honey in small quantities.

Birds disperse the drupes.

The berries are eaten in the north. The fruit and the leaves also are acid.

CROWBERRY (*Empetrum nigrum*).

In habit and adaptation to dry conditions the Crowberry resembles the Heaths, near which it is placed by some authorities, whereas by others it is placed near the Holly. It has also affinities with Euphorbiaceæ and Celastraceæ.

A rare moorland plant, Crowberry is found in all parts of the British Isles, being more common in the north and west of England and Scotland. It ascends to 4000 ft.

Those who live in hilly districts where there are heaths and moors are familiar with the Crowberry. It also grows in bogs. It is found on sandy soil on heaths in north-east Yorks with Ling and Whortleberry, and in Perth forms part of the heath formation, occurring in pinewoods in Inverness-shire. It also grows on siliceous soils with Matgrass and Blue Hair Grass, on upland moors in the Pennines in the bog-moss association, being found in peat-beds in Cotton-grass associations, on bilberry moor, heather moor, on grass moor, and in subalpine moorland associations.

Crowberry is a shrub and has the heath habit, having a tufted manner of growth, being thickly branched, hairless, with slender, wiry, spreading or trailing branches.

The leaves are evergreen, linear to oblong, crowded, short, with the leaves rolled back, adapted to dry conditions. They turn red when old, the margins are roughish, the bent-back border hiding the downy underside and forming a tube closed at both ends. The upper surface of the leaf is protected by a strong, smooth cuticle. The stomata are on the under surface, and open into the closed tube filled in part by the hairs. This is an adaptation to prevent excessive loss of water by transpiration in situations where, owing to the character of the soil or the water or to low temperature, the rate of absorption of water by the roots is slow. It also serves the purpose of preventing the stomata from being clogged by dew or rain. This last is deposited on the smooth upper surface and runs off.

The flowers are in racemes, axillary, pink or purple, small, stalkless. The sepals are rounded and hollow. The petals are somewhat spoon-shaped, with a membranous margin, bent back. The stigma is nine-rayed. The anthers are red, with long stalks. The fruit, a berry-like drupe, is black, or plum-coloured.

The flowers are in bloom in May and June. The plant is a perennial shrub, and 6 to 18 in. in height.

The Crowberry is a diœcious plant. The flowers

are wind-pollinated. But they may be insect-pollinated, by flies. A little honey is secreted. The male flowers are rose-colour, the females purple. The stamens protrude from the perianth. The pistil is short, with six to nine spreading, black, and shining stigmas. There are some plants which have complete flowers, in which the anthers ripen in advance of the stigmas. The flowers are borne on short shoots, arising laterally from the main axis.

The drupe is edible, and dispersed by birds. The drupe contains many small one-seeded stones.

The name Empetrum means growing in stony places (Greek en, petron).

The Crowberry goes by the following names: Crake-berries, Craw-berry, Crawcrooks, Croupans, Crow-berry, Crow-peas, Goose-berries, Heath, Black-berried Heath, Wire Ling, Monox Heather, Moonog, Crow Pea.

EMPETRUM NIGRUM.—*The heath-like habit of the Crowberry is admirably shown in Fig. 34. The stamens are seen to project a long way from the flower.*

CHAPTER II

CALYCIFLORÆ

IN the sub-class Calycifloræ the stamens are inserted on the calyx or disc, being perigynous on a free receptacular tube, or if adherent, on a continuation of the tube beyond the ovary, with the ovary superior as in the Spindle Wood group, Buckthorn group, some of the Pea group, Rose group, Stone Crop group, Saxifrage group, Sundew group, Loosestrife group; or epigynous with epigynous stamens on an adherent receptacular tube not prolonged beyond the ovary, and with an inferior ovary in the Willow Herb group, Mare's Tail group, White Bryony group, Purslane group, Gooseberry group, Ivy group, Hemlock group, Dogwood group.

The flowers possess both calyx and corolla. The sepals may be distinct or united. The petals are usually distinct. Except in the Pea group the flowers are regular.

The stamens are hypogynous in the Saxifrage group, in Grass of Parnassus, and amongst the Sundews. They are epipetalous in some of the Stonecrops. In some of the Pea group they are nearly hypogynous.

The petals are absent in some of the Rose group, Willow Herb group, Loosestrife group, Saxifrage group, Mare's Tail group, and Mistletoe group. In some of the Holly group, White Bryony group, and Stonecrop group the petals are more or less united.

In Crassulaceæ, Cucurbitaceæ, and Ribesiaceæ the stamens and petals are not perigynous, though placed in that section.

It has been shown that in the Water Lily group and in some of the Pink group the stamens are apparently perigynous to epigynous.

There is no disk in Aquifoliaceæ or Ilicineæ, included by Hooker in the Thalamifloræ. In the Mare's Tail group and White Bryony group the flowers are unisexual. The flowers are irregular, papilionaceous in the Pea group, and the stamens are monadelphous or diadelphous.

22. The Spindle Wood Group.

Of the order Celastraceæ there is only one British species—the Spindle Wood—which is described here.

There are about one hundred and eighty species and thirty-eight genera. These are natives of the Old World, and the Southern Hemisphere, the warmer parts of Europe, North America, Asia, Cape of Good Hope, Chili, Peru, and New Holland.

The members of the Spindle Wood group are trees or shrubs. The leaves are simple, opposite, or

alternate, often leathery, with or without stipules. In some cases the plants are spinous or climbing plants.

The flowers are small, green or purple, regular, borne in cymes, or rarely in racemes. They are usually hermaphrodite. The calyx is gamosepalous, inferior, with four to five sepals, free or united, overlapping in bud, and persistent. The corolla is polypetalous, with four to five petals, which are short, and overlapping in bud. The stamens are perigynous, four to six, inserted on the flat, swollen, or lobed disc, which covers the base of the calyx, and alternate with the petals. The filaments or anther-stalks are awl-shaped. The ovary is without a stalk sunk in the disc, superior, with three to five carpels, with as many loculi. The style is short, entire or divided into three to five lobes, with terminal stigmas. The fruit is a capsule, dehiscent or not, loculicidal, opening by valves, three-, four-, or five-angled.

The fruit may be also a samara, drupe or berry. The seeds are erect, with a fleshy aril, or arillode. The cotyledons are green, large and leafy. The flowers contain exposed honey, and the anthers ripen first. They are triœcious. Flies are the chief visitors.

Birds may disperse the seeds, which are also dispersed by the splitting of the capsule.

The Spindle Wood group shows relationship with the Holly group, Buckthorn group, Ampelideæ, and Sapindaceæ.

The properties of the plants of this group are emetic, stimulant, and acrid. The native Spindle Wood is of some economic importance. The Arabs are said to eat the leaves of one of the exotic species to preserve them from plague and to make them watchful.

SPINDLE WOOD (*Euonymus europæus*).

The orange aril enclosing the seeds of the Spindle Wood, when the pod is ripe and has opened, is a familiar object, well known to those who live in the neighbourhood of the Chalk downs in the South.

Spindle Wood is found in England and Wales, Scotland and Ireland, but it is rare in Scotland and local in Ireland.

Hedges, woods, and copses are the habitats of this shrub or tree. It occurs occasionally in woods with the sessile oak on siliceous soils, most abundantly on limestone in ashwoods, on limestone scrub, and especially on chalk, on chalk scrub, as well as in ash-oakwood on marls and calcareous sandstones. It is frequently planted.

A shrub or tree, Spindle Wood is 5 to 20 ft. high. It is quite smooth. The bark is grey, the twigs green, with four angles. The leaves are opposite, ovate or oblong to lance-shaped, minutely toothed, shortly stalked, acute.

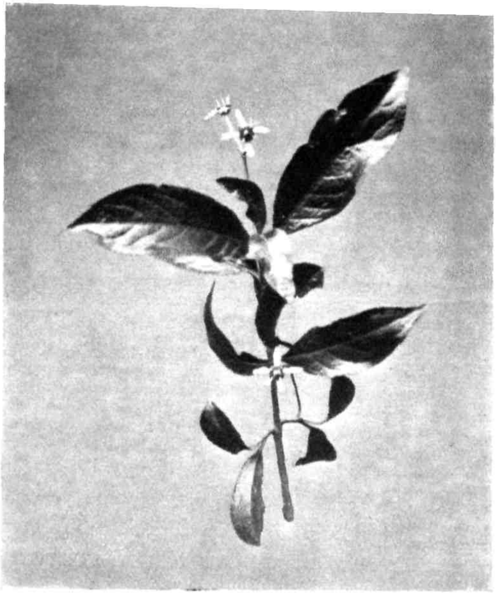
The flowers are yellowish-green or greenish-white, four-cleft, in small umbels, or dichotomous cymes,

of three to five flowers. The stalks are shorter than the leaves. The four petals are oblong or inversely ovate, twice as long as the four stamens. The fruit is a rose-coloured blunt-angled capsule, with seeds enclosed in a fleshy orange or scarlet aril.

Spindle Wood flowers in May and June. It is a perennial deciduous tree or shrub.

The flowers are polygamous, and triœcious. The male flowers contain a trace of a pistil, the female rudimentary stamens. Those flowers which appear to be complete function as male flowers, and rarely produce seed. Flies are the chief visitors. Honey is secreted by a fleshy disc around the style, and forms a thin layer quite exposed, so that short-tongued insects can reach it, especially flies. The plant is fœtid and may attract them. As the flowers are inconspicuous other insects are not attracted to them. The flies run all over the flower, so that were the flowers not separate, both as regards space and time, they would run as much chance of being self-pollinated as cross-pollinated. The anthers in the complete flowers ripen first, and stand some way from the stigmas, opening outwards before the stigma is mature; the latter opens several days later and closes up again.

The capsule opens by four to five valves, corresponding to the number of cells. When ripe it is red, and when open the orange aril is conspicuous. The embryo is embedded in albumen, with two green cotyledons and a radicle. The seeds may be



C. A. Allen. FIG. 35.—SPINDLE WOOD (*Euonymus europæus*). *See page* 185.

The Author. FIG. 36.—BUCKTHORN (*Rhamnus catharticus*), in fruit. *See page* 189.

dispersed by birds, and the seeds are also liberated when the capsule splits.

The Spindle Wood has many other names, such as Ananbeam, Butcher's Prick-tree, Catrash, Cat-tree, Death Alder, Dog-tooth Berry, Dogwood, Foul Rush, Gadrise, Gaiter-tree, Gaten-tree, Gatteridge, Louse-berry, Pincushion, Prick-timber, Skewer-wood, Skiver, Spoke-wood, Witch-wood.

The wood is used for skewers, pegs, and charcoal for drawing. The fruit is poisonous (hence euonymus, from the name for the Mother of the Furies). The fruit yields a yellow dye, and, with alum, a green dye. The carpels have been known to poison sheep. The shoots are used for pipe-stems in Germany.

EUONYMUS EUROPÆUS.—*In Fig.* 35 *note the short-stalked leaves with minute teeth, the flowers in dichotomous cymes with four oblong petals.*

23. THE BUCKTHORN GROUP.

We have in Britain two species of the Order Rhamnaceæ. The common Buckthorn, chosen as a type here, has leaves minutely toothed, branches with thorns, four stamens, and is a diœcious plant. In the Alder Buckthorn the flowers are hermaphrodite, there are five stamens, the leaves are entire, and the branches are thornless.

There are five hundred species and forty genera of Rhamnaceæ, which grow in the zone of trees in all parts of the world.

They are trees or shrubs. A few are climbing or trailing plants. Serial buds occur in the leaf-axils. The leaves are simple, opposite or alternate, three- to five-nerved, with small stipules.

The flowers are in cymes, frequently corymbose. They are small, hermaphrodite, or rarely unisexual, regular, green or yellowish as a rule. In some cases the flowers are apetalous. The calyx is gamosepalous, with four to five sepals, inferior, valvate in bud, deciduous, and the calyx-tube is leathery. The petals are five or four, small, concave, clawed, hooded, or absent, inserted on the throat of the calyx. The stamens are hypogynous, four to five, alternate with the sepals, opposite, the petals inserted with them, the latter sometimes enclosing them. The anther-stalks are awl-shaped. The anthers are small and versatile.

There is a large annular or cup-shaped disc. It may coat the calyx-tube. The ovary may be united to the receptacular tube or free from it, and is superior or half-superior, two- to four-celled, surrounded by the fleshy disc in which it is sunk, not stalked. The styles are short, simple or three-lobed, with terminal stigmas. The fruit is dry, and splits up into mericarps, dehiscent or not, or is a drupe with one or more stones. It may be united with the calyx-tube. There are several seeds, sometimes provided with an arillus.

The flowers are heterostylic in the common type, the plant being diœcious. They are complete in the

Alder Buckthorn, and visited by many insects for their honey. The fruits are dispersed by birds.

The group is of some little importance, including small trees. The berries are cathartic. A green dye is also produced from the native species.

Buckthorn (*Rhamnus catharticus*).

Buckthorn is a well-known plant distinguished by its branched habit (hence *Rhamnus*), blackish stems and twigs, and berries, and the finely cut leaf-margin and straight thorns.

It is generally distributed throughout the British Isles, being common in England, rare in Scotland, and very rare in Ireland.

Hedges, woods and thickets, bushy places, are the chief habitats of the Buckthorn, which, however, is much planted. It is especially common on chalk or limestone, but occurs in woods with the Sessile Oak on siliceous soils. It occurs in the Ashwood association on limestone, on limestone scrub, on the chalk, on chalk scrub, and in the chalk grassland association, as well as in the fen formation in ultimate carr.

A shrub in habit, Buckthorn is rigid, hairless, or hairy, much branched, the branches opposite, spreading, the smaller ones ending in a thorn, with black bark.

The leaves are roundish to oval, coarsely or finely and regularly toothed, the teeth incurved, stalked,

pointed, or blunt, the veins few and prominent, spreading at a wide angle from the midrib, from below the middle. The leaf-stalks are longer than the stipules.

The flowers are very small, in close cymose clusters, in the axils of the leaves, or solitary. The plant is diœcious. In the male flowers the calyx is bell-shaped; in the female it is cupular, with acute lobes. The flowers are yellowish-green, four-cleft, borne on short stalks.

The petals are narrow, not longer than the calyx-teeth. The styles are four-cleft (or two- to five-cleft), uniting halfway. The drupe is round, black, with four inversely ovoid stones, grooved on the back. The notch in the seeds is closed.

The plant being diœcious, each containing the rudiments of the other sex, is adapted to cross-pollination. The following forms occur: a long-styled male, a short-styled male, a long-styled female, and a short-styled female. The male flowers are larger than the female. The anthers mature first.

The fruit, a berry, is dispersed by birds.

Buckthorn is known also by the names French Berries, Hart's-thorn, Rainberry-Thorn, Rhine-berry, Waythorn. The prefix Buck is the same as Box.

The berries are cathartic (hence *catharticus*), and have been used medicinally. When mixed with alum and evaporated the juice yields a paint—sap-green.

The wood has been used for charcoal for gunpowder. A yellow dye is yielded by the berries and bark, and has been used in Russia.

RHAMNUS CATHARTICUS.—*In Fig.* 36 *the characteristic opposite, long-stalked leaves with prominent veins below, and the shining, black berries are illustrated.*

24. THE FIELD MAPLE GROUP.

There are two members of the order Sapindaceæ, or Aceraceæ, the native Field Maple which is described here, and the Sycamore or Great Maple.

The order includes over one hundred species and three genera. These plants are natives of the Northern Temperate regions, especially hilly districts, and the mountains in the Tropics. In the opposite leaves and stamens inserted on, and not within, the disc, the Aceraceæ differ from the other members of the Sapindaceæ. The order is closely related to the Spindle Wood group.

The members of the Maple group are mainly trees or shrubs. They have opposite leaves, usually stalked, with palmate veins. They are entire, simple and pinnate, deciduous. There are no stipules.

The inflorescence is a raceme, or a corymb, or is panicled. The flowers are regular, often polygamous, and the plant may have male and complete flowers on the same plant, or on different individuals, or be diœcious. The parts are in fives or fours, with a

perianth of two whorls. There is a disc which may be annular, or lobed, or reduced to teeth, or is rarely absent. The lower flowers which bloom earlier in the raceme are male, the terminal ones complete. There are four to nine sepals, and, as a rule, five petals, which are distinct. The calyx is deciduous, overlapping in bud. The petals also overlap in the bud. There are eight stamens (or four to ten) inserted on the disc, which is hypogynous. They are sometimes indefinite. In the male flowers are rudiments of a pistil. The pistil is syncarpous, and consists of two carpels being superior. The ovary is flattened. There are two styles which are slender, united below or distinct, with two stigmas. The style is stigmatic on the inner face. The fruit consists of two, three or four spreading samaras or schizocarps, which break up into mericarps when ripe. The seeds are usually single and without albumen.

These plants are adapted to insect visits, the flowers being only functionally male or female. The fruits are dispersed by the wind.

The Maples afford valuable timber-trees. Sugar is yielded by the plant, the sap being sweet. Honey-dew occurs on the leaves, extracted by species of insects, who retail it to ants.

FIELD MAPLE (*Acer campestre*).

In the Field Maple, as well as in the Sycamore, where perhaps it is better shown, we have an example

of a tree whose leaves develop a sweet sugar sap or honey-dew. Aphides or lice-like insects pierce the tissues, and suck out the juice, and this forms the honey-dew, of which ants are fond, and which they receive in return for not molesting the aphides. The aphis or "cow," on being tapped or "milked" by the ant, ejects upon the leaf the honey, which the ants lick up. The honey-dew is hygroscopic, and when dew falls it takes up the moisture, the honey-dew forms a smear over the leaf, and, on evaporation, this becomes a sort of varnish, which protects the leaves from too rapid transpiration—a case in which insects help to regulate the proper carrying out of a vital physiological function.

The Field Maple is common throughout the country, especially in the south, and native up to N. England, rare in Ireland. In Scotland it is naturalised. It occurs in the Channel Islands.

It grows in woods, thickets, and hedgerows. It is found in oakwoods on clay and loam, in woods of the sessile oak on siliceous soils; on the chalk in chalk scrub, in ash-oakwoods, on marls, and in the marsh formation.

Field Maple is a small tree, which when it attains a good size is handsome, round-headed, and may reach a height of 15 to 30 ft. The wood is used in turnery. The foliage is dense, dark green. It is often, however, only a small tree or bush in the hedgerow. The branches are spreading. The bark is corky, rough, and fissured. The wood is fine-

grained and beautiful. The leaves are opposite, short-stalked, palmate or five-lobed, the lobes broad, blunt, entire, scalloped, or wavy, kidney-shaped, downy when young. There are no stipules.

The flowers are in loose, erect racemes, or corymbs, not so long as the leaves. They are yellowish-green, few, on slender stalks. The sepals are hairy, linear to oblong. The petals are narrower. The fruit is a samara with downy carpels, the wings spreading horizontally. The eight stamens of the male flowers are as long as the corolla.

The Field Maple is in flower in May and June. It is a deciduous tree.

The flowers are often polygamous, functionally male or female, with functional stamens and a rudimentary pistil, or with a functional pistil and rudimentary stamens that do not shed pollen. The earlier lower ones may be male, the terminal ones bisexual. The sexes may occur together on the same inflorescence, and the plants may be andromonœcious, and be androdiœcious or even diœcious (or with the sexes on different trees). The honey is secreted on a disc between the petals and stamens.

The winged "samaras," really schizocarps of two carpels, are dispersed by the wind. Each chamber of the ovary contains a single exalbuminous seed, with folded cotyledons. The embryo is curved like a horse-shoe.

The name *acer* refers to the hard wood. When

polished the wood is very beautiful and used for furniture, for bowls and cups, etc. The wood yields excellent charcoal. The sap yields sugar.

The names Bird's Tongue, Chats, Dog Oak, Ketty Keys, Keys, Kite-keys, Kitty-keys, Maple, Maser Tree, Oak, Shacklers, Whistle-wood have been applied to the Field Maple.

Long life is thought to be given to children who pass through the branches, and a tree in Sussex was much visited on the basis of this superstition. When there was a rumour that the tree was about to be felled, petitions were signed in order that the tree might be left untouched.

The fruits of the maples are called shacklers or Locks-and-keys. In South Devon the tree is called Elm.

ACER CAMPESTRE.—*Note in Fig. 37 the foliage, with five-lobed, deeply-veined leaves, and the terminal, loose corymb shows the narrow petals and stamens.*

25. THE PEA AND VETCH GROUP (SUMMARY).

(*Introductory Volume, p. 84.*)

In order to illustrate this group, four species were described in the Introductory Volume belonging to the Leguminosæ, namely, Broom, Melilot, Red Clover, and Tufted Vetch.

Only one other order contains a greater number of species, there being some 7000 species and 440 genera. The order is divided into several groups,

the British species being included in the Papilionaceæ.

In the Mimosoideæ the flowers are regular and the corolla is valvate. They include such plants as the Acacia, Mimosa, etc. The Cæsalpinioideæ include those plants in which the flowers are zygomorphic, the corolla being imbricate and ascending. In the Papilionatæ the flowers are zygomorphic, papilionaceous, the corolla imbricate, descending. In the Cæsalpinoideæ are included *Gleditschia, Cassia, Tamarindus*, and *Copaiba*, all useful plants. Amongst Papilionatæ *Onobrychis* has a lomentum, in the rest the fruit is a legume or pod.

The Leguminosæ inhabit all countries, are found in all manner of habitats, and include all sorts of plants, differing in habit from the prostrate, herbaceous Bird's Foot, to the graceful trees, Acacias, often planted in this country. Some are aquatic, and many are adapted to dry soil conditions. A large proportion are climbers, as the Vetches, *Vicia*, and *Lathyrus*.

One character that they possess is of special interest, namely the power they have of fixing nitrogen, and so increasing soil fertility. This is due to the agency of nitrogen-fixing bacteria or lowly micro-fungi, which develop in tubercles or altered lateral shoots of a gall-like nature. It is the free nitrogen of the atmosphere that is absorbed by these bacteroids; hence their presence is a distinct advantage, adding to the nitrates derived from

G. B. Dixon. FIG. 37.—FIELD MAPLE (*Acer campestre*). *See page* 192.

W. F. Mayes. FIG. 38.—MARSH BIRD'S FOOT TREFOIL (*Lotus major*). *See page* 198.

the soil by the plant itself. The latter also consumes the bacteroids; hence the value of leguminous plants for a rotation of crops and as manure when ploughed in.

The British Papilionaceæ include herbs and some shrubs. The leaves are alternate, trifoliate, or simple, with stipules, and the leaflets have stipulæ.

The inflorescence is a raceme, or variety of that, a panicle or spike. The flowers are irregular. The calyx consists of five sepals united below, sometimes two-lipped, as in the Trefoils. There are five unequal petals, which are distinct or adherent by the claw to the staminal tube. The upper standard is broad outside in bud. The two wings are lateral, interior in bud, enclosing or adhering to the two lower petals. These form the keel, interior in bud, and distinct or united by the lower edge. There are ten stamens which unite to form a tube, or the upper tenth one may be separate. They are equal, or the alternate ones are longer. The ovary is one-celled. The style is bent inwards.

The stigma is oblique or terminal. The fruit is a dry pod or legume, opening along both sutures, or not. The seeds have a leathery coat.

The flowers are proterandrous, and they exhibit great variety and complexity of mechanism, such as the piston apparatus, and are explosive, with trigger arrangements.

The fruit walls frequently contract when dry, and the seeds are scattered to a distance.

Fodder and other valuable economic products are yielded by the Leguminosæ, which is one of the most important groups to Man in the plant world.

MARSH BIRD'S FOOT TREFOIL (*Lotus major*).

Lovely wild flower as the Common Bird's Foot Trefoil is, the flowers of the Marsh Bird's Foot Trefoil almost exceed the former in beauty. As the second Latin name implies the plant is larger, being much taller and more profuse.

This plant is found in all parts of the British Isles and in the Channel Islands. In Yorkshire it grows at altitudes of over 1000 ft.

Damp places, moist meadows, ditches, hedges, bushy places, marshy places are the habitats of this plant. In damp oakwoods it grows on clay or loam, and on siliceous soils in siliceous grassland associations, where mat-grass is abundant. It also grows in the limestone grassland association.

The habit is erect or ascending, and the rootstock is long, stoloniferous, branched at intervals. The plant is luxuriant, hairy or smooth. The leaves have inversely ovate leaflets. There are round to ovate stipules. The margins of the leaves and bracts are fringed with hairs.

The flowers are eight to twelve in a head or umbel, yellow, with the calyx-teeth spreading in bud, the angle between the two upper spreading teeth. They are acute, awl-like, with a triangular base. The claw

of the standard is linear. The pod is long, cylindrical, two-valved, with septa between the seeds.

The flowers are in bloom from July to September. The plant is a herbaceous perennial. It is 6 in. to 2 ft. in height.

The flowers in structure and mode of pollination resemble those of the Common Bird's Foot Trefoil. The keel is united both above and below with only a small opening at the apex. The anthers are mature before the stigma, and shed pollen into the tip of the keel. The anther-stalks of the longer inner five out of the ten stamens, which are in two groups, are thickened below the anthers, and form a sort of piston mechanism. All the anthers are at one time of the same length, but those of the five longer stamens are then withered. When these latter have shed all their pollen the inner keep the mass of pollen in place. When the wings are depressed, so is the keel. An insect doing this causes the pollen to be forced out in a little mass at the tip. The style becomes covered with pollen. The stigma, however, is only receptive when rubbed, and this is done by the insect, so that there are equal chances of cross- and self-pollination. The insect in pressing its proboscis into the flower covers itself with pollen, and bears this away to another flower. When it leaves, the flower returns to its former position owing to the elasticity of the parts and the hinging of the keel and the alæ. The flower contains honey, and the stamens are united, except one.

The pods, as the English name implies, are arranged like the fingers of a bird's foot, and when the pods open and are dry the seeds may be scattered a little distance.

Like the Common Bird's Foot Trefoil this species is a good pasture plant.

LOTUS MAJOR.—*In Fig.* 38 *the habit of the plant is well shown, also the umbel-like inflorescence, and the narrow, linear pods.*

MILK VETCH (*Astragalus glycyphyllos*).

Not a very well-known plant, Milk Vetch is not so uncommon as may be supposed.

It is found in all parts of the British Isles up to Ross, in Scotland, and appears to be frequent in East Anglia.

The habitat is fields, copses, dry open woods, bushy places, frequently on chalky or gravelly soil.

This plant is prostrate in habit, and the stems are stout, zigzag in arrangement, spreading on the ground. The root-stock is short and stout. The plant is more or less hairless and light-green in colour. The leaves have eleven to thirteen or more leaflets in pairs, the leaflets being ovate, oblong, blunt, smooth above, hairy below. The leaves are longer than the flower-stalks. The stipules are free and ovate to lance-shaped, the lower auricled.

The flowers are dull yellowish-white, spreading or drooping, borne in a short, dense, compact raceme,

The Author. FIG. 39.—MILK VETCH (*Astragalus glycyphyllos*). *See page* 200.

The Author. FIG. 40.—BIRD'S FOOT (*Ornithopus perpusillus*), in fruit. *See page* 201.

ovoid, with awl-like bracts, longer than the short flower-stalks. The calyx is bell-shaped, half as long as the corolla. The pods are an inch in length, erect, smooth, linear, round in section, curved inwards, pointed, pale, two-celled, with a thin double partition, with six to eight seeds in each half. The seeds are numerous, pale, and flattened.

The flowers open in June, and may be found in bloom as late as September. The plant is a herbaceous perennial. It is rather tall, growing to a height of 2 to 3 ft.

The tenth stamen is free, and the flowers contain honey. The petals have a long claw, and the keel is blunt. The anthers are equal. The style is slender and beardless, with a terminal stigma. The floral mechanism is adapted to insect visitors, bees, and to cross-pollination.

The pods open by two valves, and the seeds may, when the valves become tense and dry, be thrown a short distance.

Other names for this plant are Wild Liquorice, Liquorice-vetch.

ASTRAGALUS GLYCYPHYLLOS.—*In Fig.* 39 *the pinnate leaves and the flowers and young pods are illustrated.*

BIRD'S FOOT (*Ornithopus perpusillus*).

From the arrangement of the pods this pretty little wild flower is known as Bird's Foot, the pods radia-

ting from a centre, and being constricted at intervals, somewhat resembling the claws of a bird's foot (hence *Ornithopus*).

In the British Isles it is generally distributed, occurring in Scotland chiefly in the south, and in Ireland on the eastern side. It is also a native of the Channel Islands.

The plant is found in dry, sandy, and gravelly places, in dry pastures, and on sandy soil on heaths, of which last it is especially characteristic.

In habit it is a low prostrate species, the stems spreading over the ground, ascending a little at the tip. The whole plant is greyish-green and hairy. The stems are numerous, slender (hence *perpusillus*), leafy, with few branches. The upper leaves are not stalked. The leaflets are in five to ten (or more) pairs, downy, close, oblong, or linear, or elliptic, the lowest pair bent back if at the base of the leaf-stalk. There are very small stipules, as in plants with a narrow leaf base, to protect the buds.

The flowers are few, three to six in an umbel, white, the flower-stalks in the axils, slender, rigid, longer than, or not so long as, the leaves. The flowers are tinged with red, and closely stalkless above the bracts. The bracts are pinnate. The ultimate flower-stalks are very short. The calyx tube is more or less bell-shaped, hairy, with short, acute, triangular teeth. The keel is short and blunt. The pods are seven- to nine-jointed, constricted between the seeds, with a curved beak not so long as the joints, smooth or

downy, netted, or wrinkled longitudinally. The mericarps are short and oval.

Flowers may be found between May and August. The plant is a herbaceous annual. It is 4 to 18 in. in length.

The flowers do not contain honey, and are very small. The alternate anther-stalks are swollen upwards, the upper one free, and the anthers are uniform. The style is bent inwards with a pin-headed stigma. In spite of this adaptation to insect visits the flowers are apparently self-pollinated, but seed is usually set.

The pod is a schizocarp splitting into one-seeded mericarps, which fall near or at some little distance from the parent plant.

The plant is called Fowl-foot.

ORNITHOPUS PERPUSILLUS.—*In Fig.* 40 *the characteristic arrangement of the pods can be seen, and the illustration supplies an idea of the trailing habit of the plant, as well as of the pinnate leaves.*

26. THE ROSE GROUP (SUMMARY).

(*Introductory Volume, p. 95.*)

Amongst the order Rosaceæ we find representatives of many useful as well as ornamental plants.

The members of the order are nearly related to the Saxifrage group. The Myrtaceæ have a very similar floral mechanism to that of the Apple and its allies. Some of the foreign types are related to the

last group, the Pea and Vetch group. Other groups to which the Rose group is related are Calycanthaceæ, Combretaceæ, and Thymelæaceæ.

There are some two thousand species and ninety genera, of cosmopolitan distribution. Most of the plants are perennials, and include trees, shrubs, and herbaceous plants.

The leaves are alternate, sometimes opposite, simple or compound, with leaf-like stipules, sometimes adnate to the leafstalk. In this group propagation takes place vegetatively by creeping stems, or off-sets, as in the strawberry, by runners, or in the raspberry, by suckers.

The flowers are in terminal racemes or cymes, very variable in form. Owing to the hollowing out of the receptacle the perianth members are frequently perigynous. The carpels may be borne on a raised structure in the centre, even if the receptacle is cup-like. In *Pyrus* and others the carpels are united to the receptacle and inferior.

The flowers are regular, actinomorphic, and hermaphrodite. The calyx is gamosepalous, of five sepals (or four, or eight or ten), either inferior or superior, with the perianth epigynous or perigynous, usually enclosing the ovary or adherent to it.

In the Cinquefoils there is an epicalyx of outer smaller leaves, usually overlapping in bud. The corolla is generally polypetalous, with five petals, and regular, perigynous, often round and hollow, with short or no claws, deciduous, overlapping in bud.

There may be no petals, as in the Burnets and Lady's Mantle, the former wind-pollinated. The stamens are numerous, or two, three or four times the number of petals, turned inwards in bud, perigynous, inserted with the petals, or on the disc, in one or more rows. The anthers are small and usually didymous. The disc lines the calyx-tube. The pistil is usually apocarpous and superior, rarely syncarpous and inferior when the calyx-tube is adherent to the ovary. The carpels are few or numerous. The carpels may be distinct when the plant is in flower or combined into a single five-celled ovary. The style may be lateral, or at the base distinct, or united at the base. The stigma is simple, rarely feathery. The fruit is a pome (in *Pyrus*), or may consist of one or more drupes (*Rubus*), drupels, achenes (*Potentilla*), follicles, or a berry or capsule.

The honey is concealed. Usually the anthers are ripe first. Some species are wind-pollinated. A large number with edible fruits have the fruits and seeds dispersed by birds.

In this group are included many useful fruit trees, over one hundred blackberries, and many favourite garden flowers.

WILD STRAWBERRY (*Fragaria vesca*).

Every person, it may be presumed, has recollections of the days of boy- or girl-hood when excursions were made in search of the luscious scarlet fruits of the wild strawberry, in some woodland glade where

the plant luxuriates in the moist shade. And truly a feast of wild strawberries is not soon to be forgotten.

The first scientific name testifies to the fragrancy of the fruit, and *vesca* denotes its edible character.

The Wild Strawberry is general in the British Isles, as far north as the Shetlands, and in the Highlands occurs at 2000 ft. It is also a native plant in the Channel Islands.

The habitat is essentially woodland, as the wild strawberry is a shade-lover. It occurs also in bushy pastures and in hedges and thickets. It is to be found in lowland oakwoods on clay and loam, on siliceous soils in woods formed by the sessile oak. It also grows on limestone in ashwoods, in limestone scrub, on the chalk in beechwoods, on chalk grassland, and in ash oak-hazel, forming societies, on marls.

The wild strawberry is a good example of a plant which increases by vegetative propagation by means of runners. The plant is of trailing habit. The rootstock is short or long, and woody, with a terminal tuft of leaves. The stolons are continued by an axillary shoot at each rosette, in a sympodial manner. There is a scale between adjoining rosettes. The runners root and form new plants at each node. The leaves are bright green, radical, shortly stalked, downy, with soft, silky hairs, and consist of three leaflets, which are ovate, coarsely toothed, or oblong, plaited, the lateral ones cleft. The stipules have a membranous margin, and are adnate.

The flowers are white, borne on short, radical scapes, in irregular cymes which are erect, with one or two entire bracts or leaves, and are drooping. The flower-stalks are hairy, with spreading hairs, with stipule-like structures. The bracteoles are ovate, not so large as the calyx lobes, and form an epicalyx (so-called).

In fruit the calyx is spreading or bent back. The petals are as broad as long, notched, and contiguous. There is an indistinct claw. The receptacle is globose in fruit and covered to the base with achenes. The fruit is red when ripe, and is a false fruit or pseudocarp, formed in part by the receptacle which is the fleshy part, bearing on its surface the one-seeded achenes or fruits. The seeds are exalbuminous.

The Wild Strawberry flowers between May and July, and is a herbaceous perennial. It is from 2 to 6 in. in height.

The flowers of the Strawberry have the petals and stamens situated on the outer rim of the honey-secreting disc, and they are perigynous, the ovary being in this case superior. There is honey which is concealed, and the flowers are visited by bees, flies, and beetles. The stigma ripens in advance of the anthers. There are three kinds of flowers. The female flowers produce much fruit. Others are complete and not as fertile as the former. There are also male flowers. Observations show that some flowers have complete and female flowers on the same umbel. Others have complete and female flowers on different

umbels, and there are complete and male flowers on the same or on different umbels. In the absence of insects which may produce cross-pollination the plant is self-fertile. After pollination the flowers bend down to ripen the fruit.

The fruit is edible and dispersed by birds. The garden strawberry may be derived from the wild strawberry. Cultivated forms become diœcious and polygamous.

So long ago as the time of Edward I the Wild Strawberry was cultivated in this country. This plant is considered the origin of the hautboy, haut bois, or high wood of Bohemia, and was derived from that region.

The Strawberry was called Striowberige in the tenth century; streow refers to the runners like straws. In the fourteenth century the stalk and runners were used in medicine, under the name Strebery wyses. A drug was prepared from them for fresh wounds (by doctrine of signatures, red fruit the blood of wounds), and also a drug called the Drynk of Antioch.

The Wild Strawberry is called Freiser, Hedge-strawberry, Strawberry.

The Strawberry was dedicated to the Virgin Mary. It was in German legend a favourite of the Goddess Frigga, who presided over marriages, and she was said to go a berrying with children on St. John's Day.

No mother who has lost a child will eat a straw-

Messrs. Flatters and Garnett. FIG. 41.—WILD STRAWBERRY (*Fragaria vesca*). *See page* 205.

W. E. Mayes. FIG. 42.—SALAD BURNET (*Poterium Sanguisorba*). *See page* 209.

berry, or if so she would have none in Paradise. If a person suffering from a wound in the head eats a strawberry the wound will prove fatal.

FRAGARIA VESCA.—*In this figure* (41) *the habitat is depicted, and the habit of the plant is well shown, as well as the trifoliate character of the leaves, and the floral structure, five petals and perigynous stamens, with the superior ovary.*

SALAD BURNET (*Poterium Sanguisorba*).

One characteristic of this plant is suggested by the English name Burnet, or rather it applies better in the case of the Great Burnet, alluding to the brown colour of the flowers, burnet being brunette.

Salad Burnet is a familiar plant to all who live in a limestone or chalk district. Occurring in all parts of the British Isles, it is more frequent in England than Scotland, where it is more abundant on the east side. It is rare in Ireland. In the Channel Islands it is native. It ascends to 1600 ft. in Yorkshire.

The habitat is dry pastures, clefts of limestone rocks, chiefly on a dry and calcareous soil. It is found on limestone scrub, limestone grassland, chalk grassland, chalk pastures.

The habit is more or less the rosette habit with tufted, principally radical leaves, suited to a dry soil, and adapted to xerophilous conditions. The plant is hardly hairy at all. The rootstock is stout. The

stems are slender, somewhat angular, ascending, much branched, downy at the base.

The leaves are pinnate, radical, the leaflets stalkless or nearly so, ovate, coarsely toothed, smooth or downy below, fifteen to twenty in each leaf. The leafstalk is downy at the base.

The florets are light green, with a reddish-brown or purplish tinge, in heads borne on long stalks, shortly oblong, globular. The lower flowers are all male, with numerous, twenty to thirty, projecting stamens in pendulous tufts. The upper florets are female with a long style, ending in a purple, tufted stigma. There are, however, complete florets in the centre. The ripe calyx is square in section, hardened in fruit, irregularly wrinkled and pitted. The veins are netted. The lobes are oblong, the four wings are thin and entire. The bracteoles are fringed with hairs. The achene is dark and ribbed, enclosed in the winged calyx.

The flowers may be found in June up till August. The Salad Burnet is a herbaceous perennial. It is 6 to 18 in. in height.

There is no honey in the florets as in Great Burnet. The flower-heads are small. The stamens are numerous and the flowers are wind-pollinated, this plant being an example of an anemophilous flower. The anthers project on long stalks, which are slender and drooping, and white, yellow, or red, the anthers yellow or red.

The stigmas are numerous also and long, so that

pollen is easily caught by them. However, a few flies, solitary wasps, etc., visit the flowers, which are rendered conspicuous by the coloured stamens.

The achenes enclosed in the hollow development of the receptacle or so-called calyx-tube, one or three, fill the receptacle, and are one-seeded. The winged receptacle helps to disperse them by aid of the wind.

The first scientific name, *Poterium*, means a little drinking-cup, the plant being used as a flavour for wine, so at least Pliny says. It was put in tankards in early times in this country. The name *Sanguisorba* refers to its supposed blood-staunching properties by doctrine of signatures. It was used as part of a drug for preventing festering of wounds in the fourteenth century. Chaucer mentions it as one of the plants used for the drug "save." The plant is nutritious and a good fodder plant. It is astringent, and has been used as a salad.

Burnet, Pimpernel, Pimpinell, Salad Burnet, are the only names for this plant.

POTERIUM SANGUISORBA.—*The habit of the plant is well figured in Fig. 42, where also the foliage is shown to advantage, and also the form of the flower with the lower male flowers and their numerous stamens.*

27. THE SAXIFRAGE GROUP.

Though allied to the Rose group, the members of the order Saxifragaceæ differ from the former in

having a definite number of stamens (five or ten, etc.), and no stipules. The carpels are united into a single ovary, separating the group from the Stonecrop group, and in the distinct styles and more adherent ovary the Saxifrage group differs from the Loosestrife group. The Saxifrages are also related to the Sundew group.

Included in this group, which is divided into seven divisions, are some favourite garden or greenhouse flowers, as *Francoa*, *Philadelphus* (= Mock Orange), *Deutzia, Hydrangea, Escallonia.* Amongst British types are the Saxifrages, Golden Saxifrages, Grass of Parnassus, Currant and Gooseberry.

There are some six hundred species and seventy genera found throughout the world, the Saxifrages ranging into high latitudes and growing at alpine altitudes. Most of these plants grow in the Northern Temperate or Arctic regions, a few in the Andes and Southern Temperate zone.

The group consists of a few trees or shrubs, but chiefly herbaceous plants. The leaves are opposite or alternate. The Saxifrages have the rosette or cushion habit. Most of the plants are perennial. There are no stipules as a rule, or, if so, they are adnate to the leaf-stalk, which is often swollen.

The inflorescence is either a raceme or a cyme. The flowers are usually regular, hermaphrodite or complete, cyclic, with the parts in fives except the carpels. The receptacle may be either flat or

hollowed out, and the stamens and perianth may be either perigynous with a superior ovary, or epigynous with an inferior ovary. The calyx is gamosepalous and may be superior or inferior. It usually consists of five or four sepals united below, free, or more or less adnate to the ovary, overlapping or valvate in the bud. The corolla is polypetalous, with five petals, sometimes five united, or four, or none, overlapping or valvate in bud, inserted between the sepals. There are five or twice as many stamens, which are perigynous, in two whorls. The carpels are two, spreading at the apex, or as many as the petals, the pistil being syncarpous. The styles are distinct, or united, the stigmas having a small head. The fruit is a capsule or berry, one- to three-celled, or a follicle and many-seeded. The seeds contain abundant endosperm. The flowers are honeyed and the anthers ripen first.

The fruit is dispersed by birds when a berry, as in *Ribes*, or the seeds in Saxifrages are blown out of the capsule by the wind.

Some Saxifrages are partly insectivorous, many are crevice plants. In the gooseberry and currants we have valuable fruit-trees. The Saxifrages, as London Pride, are lovely garden flowers.

Meadow Saxifrage (*Saxifraga granulata*).

Not all the Saxifrages are confined to Alpine districts, and the one here described is typically lowland, and one of our loveliest wild flowers. The

English prefix denotes its predilection for meadows. Another characteristic is noted by the second Latin name, referring to the little granulate tubers, or bulbs or bulbils, grain-like, produced in the axils of the lower leaves. The name Saxifrage, applied owing to the fact that the plants may grow in clefts (stone-breaker) and help to widen them, was also in the long past connected with a supposed remedy for "stone" in man, by doctrine of signatures.

Meadow Saxifrage is a generally distributed plant, found in most counties in the British Isles. It, however, is not found in the Highlands and is rare in Ireland. In Yorkshire it ascends to 1500 ft.

Sandy and gravelly slopes or banks, meadows, and pastures are the chief habitats of this plant. It grows on clays and loams in neutral grassland.

The habit is that of a rosette plant, with a tufted manner of growth, with numerous radical leaves, which are succulent and hairy, and the plant is thus adapted to dry conditions. It is propagated vegetatively by the brown, downy, scaly bulbils.

The whole plant is glandular, downy. The stem is erect. The leaves are radical, stalked, kidney-shaped, palmately lobed, or scalloped. The stem-leaves are without stalks, with the lobes of the leaves more deeply and acutely cut. The leaf-stalks are channelled, to allow the water to drain off the leaf-surface. The lower leaves are stalked.

The flowers are large, three to six, bell-shaped, drooping, white, in a close, cymose, terminal panicle.

The calyx is half inferior, adherent to about the middle of the ovary, the lobes blunt, half as long as the petals. The petals are large, inversely ovate to oblong, two to three times as long as the calyx-lobes, which are erect. The stigmas are large, kidney-shaped. The capsule has slender beaks.

The flowers are in bloom in May and June. The plant is a herbaceous perennial, 6 to 12 in. high.

Honey is secreted by the outer wall of the ovary and generally exposed. Many insects visit the flowers. The anthers are ripe first. The flowers thus stand a good chance of being cross-pollinated by insects.

The capsule opens above, and the small seeds are jerked out by the wind.

The Meadow Saxifrage is known in various parts by the names Billy Button, Cuckoo-flower, Fair Maid of France, First of May, Thirlestane Grass, Lady's Pincushion, Pretty Maids, Sassifax, Saxifer, Saxifrage, White Saxifrage, Sengreen, Stone-break.

In Devon the Saxifrage is known as Bird's Eye, but this refers to the London Pride, a garden flower, rare in the wild state. In the same county it is called "Garden gates," and "Kiss me, love, behind the garden door," or simply "Meet me, love."

SAXIFRAGA GRANULATA.—*The Frontispiece shows the habitat of the Meadow Saxifrage and also the habit, and the form of the flower.*

RED CURRANT (*Ribes rubrum*).

Associated in the popular mind mainly with the kitchen garden the Red Currant is not a very conspicuous member of the British flora, being a woodland plant which occurs only sporadically, or here and there. Doubtless in many cases its distribution is largely artificial, the fruit or berry being dispersed by birds.

In the British Isles the Red Currant appears to be native or indigenous in the north of England and Scotland, but not elsewhere. In Yorkshire it is found at 1000 ft. It is also found in Ireland.

One may expect to find this shrub in woods and thickets, by the sides of streams, and in rocky places. It is found in tussock swamps in fen carr, and in ultimate carr.

The Red Currant has the typical shrub habit. It is erect and branching. Unlike the Gooseberry, which has prickles or emergences, the Red Currant has none. The leaves are plaited in the bud, smooth, or with a few hairs above, oblong below, long-stalked, with three to five short and broad-toothed lobes, angular, heart-shaped at the base, the lobes scalloped, triangular.

The flowers are small, greenish-white, numerous, in racemes, erect in flower, drooping in fruit. They are axillary at the base of the annual shoots, downy, without glands, and the ovate bracts are not so long as the ultimate flower-stalks. The calyx is hairless,

with a flat limb. The calyx-segments are broadly spreading, inversely ovate, twice as long as the petals. The petals are very small. The berries are red when ripe, acid.

The Red Currant flowers early in April and May, and fruits in June and July. It is a deciduous shrub, from 3 to 5 ft. high.

The anthers and stigma are ripe together. The flowers are yellowish-white or green. The flowers are flat and wide open, fairly conspicuous. The honey can be readily obtained by all classes of insects, such as Hymenoptera, including the hive-bee. An insect touches the anthers with one side of its head, when it presses it into the flower, and the stigma with the other. As the flowers are pendulous the honey is protected, and pollen may fall on the stigma so that there are even chances of cross- or self-pollination. Seed is usually set.

The fruit, being an edible berry and attractive, red when ripe, is dispersed by birds.

Currant is so named after the small grape of Corinth, or grocer's "currants." *Ribes* is an Arabic name for a kind of Rhubarb. The wild currant has been cultivated for a long period.

Garnet-berry, Gazels, Red Gooseberry, Gozill, Raisin Tree, Raspberry, Rizzles, Russles, Wine-berry, are names by which the plant is also known.

RIBES RUBRUM.—*In Fig.* 43 *the foliage is shown and also the fruit.*

28. The Stonecrop Group.

Of the order Crassulaceæ there are some four hundred and fifty species and fifteen genera. The order includes Stonecrop, House-leek, Navelwort amongst British plants. The members of the Stonecrop group are found in all parts of the world, especially in South Africa.

Most of them are succulent, fleshy plants, which are full of water, and adapted to dry conditions, growing in crevices of rocks, or on ledges. They have also a very characteristic habit, being cushion plants, with a matlike or tufted habit, with leaves and stems closely packed together. The surface is often coated with wax, and the stomata are immersed in the epidermis—further adaptations to dry conditions. They are largely propagated vegetatively by offsets, or by bulbils, or by adventitious buds on the leaves.

The Stonecrop group includes succulent herbs and shrubs. The leaves are alternate or opposite, without stipules. The stems are frequently glandular.

The flowers are usually in terminal or axillary cymes, regular, actinomorphic, and hermaphrodite, but sometimes unisexual, with or without bracts. The calyx is gamosepalous and inferior, with three to five, or ten to twelve, or more sepals, which may be distinct or united below. The calyx is persistent. The petals are of the same number, and sometimes, as in the Navel-wort, gamopetalous, usually poly-

The Author. FIG. 43.—RED CURRANT (*Ribes rubrum*), in fruit. *See page* 216.

Rev. C. A. Hall. FIG. 44.—NAVEL-WORT (*Cotyledon Umbilicus*). *See page* 219.

petalous. The stamens are also of the same number or twice as many, perigynous, frequently obdiplostemonous, the outer opposite the petals. The receptacle is not usually cup-like, but the parts of the flower may be perigynous. The pistil is syncarpous, with as many carpels as petals, and free, as if the pistil were apocarpous, but they may be partly united below. The styles are short or long, with a small stigma. The ovules are numerous or indefinite. The fruit is a collection of three or more one-celled, two- (or more) seeded follicles. The seeds are very small, oblong, with little or no endosperm.

There is a honey-secreting scale at the base of the carpels, the honey lying freely exposed, and accessible to flies. The anthers ripen first.

The small seeds are blown out of the follicles by the wind.

The foliage is acrid and the plants are emetic. They contain tartaric and malic acid. Some of the plants will live out of the earth a long time by aid of the large store of water they contain; and every botanist knows how necessary it is to kill the cells of a *Sedum* before drying the plant for the herbarium.

NAVEL-WORT (*Cotyledon Umbilicus*).

Pennywort, another name for this plant, is descriptive of the peculiar shape of the leaves, which are round, like a penny. The second Latin name alludes to their inversely conical form, like an umbilicus or

navel. A similar cavity in the shells of univalve mollusca is also called an umbilicus.

The name Cotyledon (from the Greek cotule) also alludes to the cup-like form of the leaf. It has been usual recently to add *veneris* to the second name, meaning Venus's.

Navel-wort is a typical example of a crevice-plant, or chomophyte, and the suitable habitats for this plant are where rocks are exposed at the surface, and are not covered with soil, or very slightly. These hard rocks, since only such types resist the action of weathering for long periods, are chiefly found on the west coast of England and more generally in Scotland. East of the Pennines, with the exception of the newer range of hills in the south, soft and usually calcareous, the country is a vast plain, as in East Anglia (where this plant is absent) and the Midlands. In the plains one cannot expect then to find this plant, but only where the older rocks are to be found on the west coast of England, in Wales, and Scotland, and in Ireland in the west and south-east, generally speaking. It also occurs in the Channel Islands. In Wales it ascends to 1000 ft., and higher in Yorkshire and Scotland.

The habitat is a cleft or crevice in rocks, often streaming with water at some seasons, but exposed to drought at others. It is also to be found on walls and buildings, but its natural habitat is rocks, siliceous as a rule.

The plant has the rosette habit, and is succulent

like other dry-soil plants. The rootstock is tuberous, almost woody. The stem is simple, stout, round in section, and is practically a scape. The radical and lower leaves are long-stalked, fleshy, round, scalloped, concave, and peltate, or shield-shaped, with the stalk inserted below the lamina. The stem-leaves are spoon-shaped, an upper one wedge-shaped.

The flowers are greenish-yellow or creamy-white, borne in a raceme, and are close. The flower-stalks are short and slender. The bracts are entire or long. The corolla is cylindrical, afterwards enlarged, with four to five short lobes, and encloses the stamens and carpels. The calyx is minute. The stamens are adnate to the corolla tube and included. The fruit is a follicle, with many seeds.

The flowers are in bloom from June to August. The plant is a herbaceous perennial, 4 to 12 in. high.

The anthers ripen in advance of the stigmas. Few insects visit the plant, except small insects called Thrips or Thysanoptera, and these do not play any part in pollination. The pendulous position of the tube protects the flowers from rain. The honey is secreted at the base of the ovary.

The follicle opens and the seeds may be scattered some distance by the wind.

Bachelor's Buttons, Corn-leaves, Cups-and-saucers (in Somerset), Cut-Finger, Penny Grass, Wall-Penny Grass, Hipwort, Jack-in-the-Bush, Kidney-wort,

Lady's Navel, Lover's Links, Maid-in-the-mist, Milk-the-cows, Money-pennies, Navelwort, Venus' Navel Wort, Pancakes, Penny Caps, Penny Cake, Penny Hat, Penny Leaves, Penny Pies, Penny-plates, Penny Wall, Pennywort, Great Stonecrop, Wall Wort are the vernacular names of this wild flower.

COTYLEDON UMBILICUS.—*The illustration (Fig. 44) gives an admirable notion of the habitat of Navelwort, and the curiously umbilicate leaves and long racemes of flowers are well shown.*

WHITE STONECROP (*Sedum album*).

Like the last, also a member of the Stonecrop group, White Stonecrop shows similar adaptations to dry conditions, the plant being fleshy and succulent.

This species may perhaps be regarded as native on the Malvern Hills and in Somersetshire. A somewhat similar form also occurs in Ireland, near Cork. Elsewhere it seems to be introduced from gardens, and is not uncommon.

Old walls, rocks, cottage roofs, are the habitats of the White Stonecrop.

This is one of the plants that has the cushion habit, covering wide surfaces as a mat, hence the first name *Sedum* (from *sedeo*, sit). The rootstock is creeping and prostrate, ascending at the tip. In winter, short, leafy, barren, purplish stems, with crowded,

rooting, prostrate branches are produced; and in summer erect flowering branches, curved at the base. The whole plant is quite devoid of hairs, but there are generally a few glands. The leaves are spreading, alternate, nearly cylindrical, or oblong to linear, narrow at the base, bright green, blunt, flattened above, scattered.

The flowers are quite white (hence *album*), or slightly pink, and are small and numerous, in smooth, terminal cymes or corymbs, forming a much-branched panicle-like inflorescence. The sepals are green, short, blunt, and oval. The petals are small, oblong to lanceolate, blunt, three times as long as the sepals. The fruit is a follicle, with small seeds.

June and July are the months in which to find the White Stonecrop in flower. It is a herbaceous perennial, 3 to 5 in. high.

The anthers ripen before the stigmas and there is every possibility of cross-pollination. The flowers, moreover, contain honey, and, being somewhat conspicuous, may attract numerous insects.

The follicle opens above and the seeds are dispersed by the wind.

The Stonecrops are adapted, as has been noticed above, to drought. The leaves are fleshy in order to check too rapid transpiration, the volume being in proportion greater than the surface. The fleshy character is also useful as a means of laying up a store of water. The liquid may also be of such a nature that transpiration is retarded, resinous fluids

facilitating this. Another adaptation in the leaf is that the chlorophyll granules arrange themselves in position according to the intensity of the illumination.

Worm Grass, Prick Madam, Great Stonecrop, are the other names.

The Stonecrop or House-leek used to be named Thunder-beard, and if the latter was planted on a house roof it served as a talisman against lightning.

SEDUM ALBUM.—*The barren shoots of flowering stems with the creeping rhizome and rootlets are shown in Fig.* 45, *with the terminal corymb, and the flowers show the sepals and petals, stamens and ovary.*

29. THE SUNDEW GROUP.

In Britain we have three representatives of the order Droseraceæ or Sundews. There are some other foreign types which are also, like our own plants, insectivorous. These include *Dionæa* and *Aldrovanda*, in which the leaves are sensitive and close up when touched. In the other genera *Drosophyllum*, *Drosera*, *Byblis*, *Roridula*, the plant catches its prey, consisting of insects, by aid of sticky tentacles which cover the upper surface of the leaves.

There are about a hundred species of this order, members of the foregoing six genera. The Sundews proper include a large number of species, which are found in all parts of the world, especially Temperate

W. E. Mayes. FIG. 45.—WHITE STONECROP (*Sedum album*). *See page* 222.

FIG. 46.—SUNDEW (*Drosera rotundifolia*), WITH ALPINE LADY'S MANTLE IN THE BACKGROUND, AND BOG MOSSES (*Sphagnum*) IN THE FOREGROUND.

G. B. Dixon. *See page* 226

Australia. The other genera are not so universal in distribution. *Aldrovanda* is an aquatic type. The Sundews grow on heaths or bogs where nutriment, apart from their insect victims, is poor. The habit seems to be derived from a specialisation of the ordinary glands found in many plants which often secrete sticky or other liquids.

The members of this group are perennial, herbaceous, usually rosette plants, with the leaves entire, and variable in form, spreading out horizontally. The leaves are mainly radical and covered with glands, with stipules, a few stem-leaves being produced, which are alternate.

The flowers are in terminal, circinate cymes, or racemes, sometimes solitary. They are regular, symmetrical, and hermaphrodite. The bulk of the flowers are hypogynous, or perigynous in exotic species, and such types have been included in the Thalamifloræ. They show affinity with the Saxifrage group, some of the members of which are semi-insectivorous, and also with *Parnassia*, which has been included in the group. The parts of the flower are in fours or fives.

The calyx is made up of five (or four to eight) lobes, and is persistent, imbricate in bud, distinct from the ovary. The corolla is regular, and made up of five petals, distinct or united at the base, imbricate or convolute. The stamens, which are four to twenty, usually five, alternate with the petals, and are almost hypogynous. The pollen is in tetrads as in the

Heath group. There are two, three, or five carpels, which are united. The ovary is single and one- to five-celled. The placentæ are usually parietal. There are one to five or six to eight styles, which are long, simple, or divided into two. The stigmas are simple or much branched. The ovules are three to many.

The capsule is loculicidal, two- to five-valved, one- to five-celled. The seeds are numerous, with endosperm.

There are some foreign Sundews that are poisonous. It has been suggested that *D. lunata* might produce a dye. The common Sundew described here is acrid and caustic. Rossoli is distilled from the juice in Italy. Milk is curdled by it, and it has been regarded as a cure for warts and corns.

SUNDEW (*Drosera rotundifolia*).

This interesting plant is an example of an insectivorous plant. In the British flora there are other similar animal-devouring plants such as Butterwort, Bladderwort, Toothworth, etc., but the Sundew is perhaps the best example. Its insectivorous properties are more marked, and the operation is more rapid in this case. On the leaves there are fine reddish filaments which are club-shaped at the tip, and bear glistening drops (hence Drosera, Sundew). These stand out from the leaves, and are like the glands in the Butterwort, being borne on the upper

surface only, the leaves being smooth and without hairs beneath. These filaments are not of equal length, but look like a number of pins stuck in a pin-cushion, those in the middle being erect and very short; the marginal ones are longer, with some of intermediate size between. There are in all about two hundred on each leaf. The tip of the filament is a gland. It secretes a clear, thick, sticky substance or fluid, which is capable of being drawn out into threads. These filaments are sensitive to the touch and to hard substances, but not to the influence of weather, rain, etc. When touched, a sticky fluid is poured forth. This is an acid, but not of the nature of pepsin. If an insect should alight upon one of these glistening filaments or tentacles, mistaking them for honey-secreting glands, the juice flows, and then a sort of ferment is produced of the nature of pepsin. The plant thus, in withholding the latter substance, according to the nature of the stimulus, exhibits selective choice, due to a fine adaptation to the mode of obtaining its animal food. This selective power is one of the most marked phases of sensitiveness in the plant world. Insects that do settle upon the tentacles, especially small flies, midges, ants, etc., become entangled in the mesh of filaments and are caught by the sticky juice, and are unable to fly away.

By degrees they are overwhelmed by it and become suffocated and die. The tentacles in the Sundew move in response to contact with animal matter.

The longest tentacles are the most sensitive. But, if one tentacle only is sensitive to contact, the rest soon move in response, after a few minutes, making an angle of ninety degrees in the movement. The position of the object is also discerned, if one may use such a word; and if, in the centre, the tentacles close over it, and if there is more than one object, they group themselves accordingly.

The entire leaf also exhibits movement, becoming hollow above. An insect caught at the margin is gradually brought into the centre.

It takes about two days for a small insect to become absorbed and finally dissolved by the acid and pepsin; the hard parts being of course untouched. Not only small insects, but larger types, such as beetles and butterflies, share the same fate, and quite a collection of different types may be found on a leaf. Not only are the tentacles sensitive to contact, but even parts of the leaf surface, at a distance. This action is comparable with the nervous system in animals. The cell-contents exhibit aggregation, and the transmission of the stimulus can be observed by the character of the liquid in the vacuoles. After the insect has been "digested," the tentacles resume their former position, ready for the next victim.

The Sundew is abundant in all parts of the British Isles where there are bogs or moors, but these are, owing to drainage, etc., becoming much less numerous than they were.

The habitat is spongy bogs and moors, heaths, etc. The Sundew is found in the wet heath association on sandy soils, in the siliceous grassland association, in the fen association, in estuarine moors, on sphagnum moors on lowland moors, in the beak sedge association, in the heather moor association on the upland moors of the Pennines.

The Sundew has the rosette habit with a creeping rhizome, the root-stock being short and slender. The stem is very short. There are autumnal stoles with bulbils. The leaves are horizontal, on long stalks broadly obovate or nearly round (hence *rotundifolia*), with long, sticky tentacles above, glandular at the tip. The margin is glandular and the leaf is hairless above. The leaf-stalk is hairy, swollen at the base, which is sheathing.

The flowers are white, in series, borne on slender scapes with awl-like bracts, and are erect and smooth, the upper part forming a once forked, one-sided raceme, turned back at first, then straight. The ultimate flower-stalks are bractless. The parts of the flowers are in sixes. The petals exceed the sepals, and open in the sun. The anthers are white. The styles are divided into two branches and bent inwards. The stigmas are white, club-shaped, undivided. The capsule is acute, longer than the sepals. The seeds are long, spindle-shaped, pointed both ends, the testa longer than the small, ovoid albumen, and loose, chaffy, and netted.

The Sundew flowers in July and August, and is a

herbaceous perennial. The plant is 3 to 6 in. in height.

The flowers rarely open and are cleistogamic, the anthers and stigma being ripe simultaneously, and thus the flower is self-pollinated as a rule.

The capsule opens by two to five valves, and the small seeds may be dispersed by the wind.

The nutriment obtained by the digestion of insects is devoted largely to the formation of seed. The insectivorous habit seems to be a further stage in the development of glands upon plants, which is of frequent occurrence. In the Rue-leaved Saxifrage the glands on the plant serve the same purpose, but are not so specialised for this end as in the true insectivorous plants.

The Sundew has been called Lust-wort, Moor-grass, Moor-wort, Red Rot, Rosa-solis, Sun-dew, Youth wort.

"Sin" is found in the prefix seen in the name Sundew, and means "ever."

DROSERA ROTUNDIFOLIA.—*In Fig.* 46, *with the Sundew, which has the leaves expanded and the tentacles erect, are plants of* ALCHEMILLA ALPINA *and* SPHAGNA.

30. THE MARE'S TAIL GROUP.

In the Order Haloragaceæ are included the Mare's Tail, Water Milfoils, and the Starworts. They are all aquatic plants or members of the marsh form-

ation. The Mare's Tail, however, is frequently terrestrial, as are some of the Starworts occasionally, and so amphibious.

There are nearly a hundred species placed in eight genera, of cosmopolitan range. A large number of the exotic types are natives of Australia.

Their affinities are with the Willow Herb group, but they are also related to the Saxifrages.

A marked characteristic of the group is the reduced and small flowers.

They are aquatic, herbaceous plants or shrubs. The leaves are opposite, or alternate, or frequently, in the British types, in whorls. There are no stipules, as is normal in aquatic types.

The flowers are very small, hermaphrodite or unisexual. In the Milfoil the upper flowers may be male, the lower ones female, and the intermediate flowers hermaphrodite. They are regular, and the stamens and perianth are epigynous, with the parts usually in fours. There are bracteoles as a rule. The perianth is in one or two whorls or absent.

The calyx is superior, with two, four, or no sepals or lobes, valvate or slightly overlapping in the bud; and it is adherent to the ovary. It may be practically reduced to a mere ring without lobes. If petals are present, as in Water Milfoil, they are very small, and inserted on the calyx. They are wanting in Mare's Tail and the Starworts. The stamens are four to eight or only one (in the Starworts), and in the complete flowers epigynous, obdiplostemonous, the

outer whorl opposite the petals, with very short anther-stalks. The stamens are long, except in the Starworts, four-angled, with lateral slits.

There is either no disc or a very small one. The ovary consists of two to four carpels, or one, united below, and inferior. The styles (which are distinct) and stigmas are of the same number as the carpels. In the Starworts there are two. The fruit consists of drupes or nuts, two- to four-celled, indehiscent, or one to four, small, one-seeded. The seeds are pendulous and solitary.

The properties of the group are quite unimportant.

In Mare's Tail the leaves are entire and in whorls and the flowers are apetalous. In the Water Milfoils the leaves are all in whorls, or the lower ones much divided, and there are two to four petals; in the Starworts the leaves are all opposite and entire, and the flower has no perianth.

MARE'S TAIL (*Hippuris vulgaris*).

The name Mare's Tail (a translation of the first Latin name) is applied to the habit of the plant, which is not unlike that of the Horsetails (plants much lower in the scale, or Cryptogams), in which the stem is clothed with whorls of slender branches, which resemble a horse's tail.

This is an aquatic plant, like the Horsetails, and the reduction in the leaf-surface is an adaptation to the aquatic habit. Really such slender leaves are

characteristic of plants submerged in the water, where the light is more diffused, and for this reason broad leaves would be less advantageous to the plant in its effort to catch the rays of the sun to carry out the vital functions of carbon assimilation, etc. Floating plants have broad leaves, the upper surface being in this case fully exposed to the light and the air. Therefore it is possible these half-submerged, aquatic Horsetails and Mare's Tails have been originally submerged, and the Mare's Tail, in fact, has entirely submerged leaves at an early stage.

The Mare's Tail is found in most parts of the British Isles, but is nowhere common, though perhaps more abundant in Ireland than elsewhere.

The habitat is shallow ponds, ditches, lake margins, pools, etc. Mare's Tail sometimes grows at the margin, sometimes in the middle, of a shallow lake. I have seen it growing (as do Horsetails also) on dry ground on the borders of a reservoir which has become reduced in area and depth, competing well with such plants as Pondweeds, likewise stranded on the dry sloping banks, fifty yards from the water.

This plant is found as a submerged or nearly submerged plant also in the freshwater aquatic formation in water relatively rich in mineral salts, but nearly stagnant. It occurs in the broads of East Anglia in the submerged leaf zone.

It is of aquatic habit, with submerged leaves and half-submerged stems. The rootstock is stout, creeping, submerged. The stems are erect, simple,

or rarely branched at the base, round in section, with many joints. In rare cases it is floating, limp, and does not flower. The upper part of the stem may stand out of the water to the height of a foot. The leaves are in crowded whorls of eight to twelve, rarely spiral, and are flat, linear, acute, entire, with a hard point on the erect stems. The submerged leaves are transparent, smaller upwards, but usually longer than on the aërial stems. The tips of the leaves are withered.

The flowers are minute, green, unstalked, in the axils of the upper leaves. They are apetalous. The calyx has an imperceptible border. There is only one stamen (or none), one awl-like style, one ovule and seed. Nature has here reduced the floral output by the most rigid economy in all the parts. The anthers are red. The ovary is globular or oblong, and crowned by the calyx, bearing the stamen and slender style. The fruit is a one-seeded nut or drupe, which is small, green and smooth.

The flowers, if they can be dignified by such a term, are in bloom in June and July, and I have found them on occasion as late as September, when the fruit is usually mature.

The plant is a herbaceous perennial, 6 in. to 2 ft. in height, or in the case of the submerged form, 1 to 4 ft. in length.

The flowers are sessile in the axils of the leaves, and are hermaphrodite, or are female when the epigynous stamen is absent. They are wind-pollinated.

The Author. FIG. 47.—MARE'S TAIL (*Hippuris vulgaris*). *See page* 232.

1. Section of stem. 2. Anthers and stigma. 3, 4, 5. Anthers and stigma.
6, 7. Seed and cross section of same.

The fruit is dispersed by water, and wind actuating the water.

The plant is also called Bottle Brush, Cat's-tail, Cats'-tails, Joint-weed, Knotgrass, Mare's Tail, Paddock Pipes, Paddow Pipe, Witches' Milk.

HIPPURIS VULGARIS.—*In Fig. 47 the habit of the Mare's Tail is shown, also a section of the stem, anthers, and stigma, anthers and stigma in another stage, and the seed and a cross-section of the same.*

WATER MILFOIL (*Myriophyllum spicatum*).

Like the last plant the Water Milfoil is an aquatic plant, which, however, is entirely submerged, and exhibits in its habit complete adaptation to aquatic conditions. The stem in such plants is limp and weak, thus enabling them to be borne with the current, and to support themselves in this manner, having no woody tissue. Many are hollow-stemmed. The leaves are very narrow, linear, finely divided (hence *myriophyllum*), and born in whorls in many cases, an arrangement which gives them, with the long internodes in each whorl, the best conditions for obtaining as much light as possible. Further, proportional to their volume, the leaf surface is large. These plants may be sometimes amphibious.

The plant is common in most parts of the British Isles. In the Highlands it rises to an altitude of 1200 ft.

The habitat is aquatic, ponds, ditches. The Water Milfoil occurs in the freshwater aquatic formation,

in waters relatively rich in mineral salts, but nearly stagnant, as a submerged plant and in the closed reed swamp in the Broads.

The habit is aquatic, the rootstock being creeping, rooting in the mud under the water. The stems ascend (in flower) to the surface, but are usually submerged and are more or less branched. The leaves are in whorls, submerged, in fours, threes or fives, and the segments of the pinnate leaves are hair-like, linear.

The flowers are borne in a spike (hence *spicatum*), (which is aërial, erect in bud, above water), and are minute, in small whorls, the floral leaves in fours, pectinate, with short bracts. The uppermost flowers are entire, male, with oblong anthers, on very short stalks, which project beyond the calyx and corolla. The lower flowers are female, very small. The capsules are nearly globular or oblong, and separate into four one-seeded carpels.

The flowers are to be found in June, July and August, and the plant is a herbaceous perennial. It is a floating plant.

The flowers are pollinated by the wind. There may be intermediate hermaphrodite flowers in the inflorescence.

The capsule or drupe is two- to four-lobed. The one-seeded carpels are dispersed by the water.

Names given generally to plants of this genus are Meakin, Water Milfoil.

MYRIOPHYLLUM SPICATUM.—*The pectinate character of the foliage is shown in Fig.* 48, *also the whorls of*

The Author. FIG. 48.—WATER MILFOIL (*Myriophyllum spicatum*). *See page* 235.

'. H. Crabtree. FIG. 50.—PURPLE LOOSESTRIFE (*Lythrum Salicaria*). *See page* 240.

leaves, the fine awl-like character of the leaflets being an adaptation to aquatic conditions.

WATER STARWORT (*Callitriche verna*).

Some notion of the characteristics of this plant may be obtained from the English name Starwort, which refers to the star-like form of the terminal rosette of leaves. The form of the leaves is again suggested by the first Greek name "Callitriche," from *kalos*, beautiful, and *thrix*, hair, the leaves being narrow, though hardly hair-like.

This species is found in every part of the British Isles, southward from Shetland, ascending to 2200 ft. in the Highlands. It occurs also in the Channel Islands.

The plant is aquatic, and found in ponds and ditches, slow-flowing streams, shallow water, and on wet mud. It is a member of the freshwater aquatic formation.

The Water Starwort is a submerged plant of aquatic habit, with long, limp, tufted stems. Like most water plants it is devoid of hairs, floating or creeping or rooting in mud, round in section, with few branches. The floating leaves are ovate to spoon-shaped, notched, three-nerved, forming a rosette (or these may not be produced), the submerged leaves linear, narrow, blunt, notched at the tip.

The flowers are small, solitary, in the axils between two minute white bracts, which are not persistent, and bent inwards.

The male and female flowers are sometimes in opposite axils. The male flowers have one stamen with a long filament. The anther-stalk is very slender. The female flowers consist of a nearly stalkless ovary with two erect or bent-back styles. The carpels have a shallow furrow which does not extend to the base of the lobes. The fruit is longer than broad, slightly keeled on the back, convex on the side of each pair of lobes, and the keels are united below for half their length.

The flowers are to be found between May and September. The plant is a herbaceous annual or perennial. Starwort is submerged, growing to a length of six inches to a foot in water.

The flowers are unisexual. The plant is monœcious. The stigma ripens before the stamen. Pollen is carried by insects, wind, or water. The pollen grains have no extine or outer coat, and float on the water. The fruit is dispersed by water, and is a schizocarp, each carpel splitting when ripe.

Water Chickweed, Water Fennel are the only other names for the plant.

CALLITRICHE VERNA.—*The terminal rosette of leaves is shown in Fig.* 49, *and also flowers in the axils of the leaves lower down.*

31. THE PURPLE LOOSESTRIFE GROUP.

Few plants in the British Flora exceed the Purple Loosestrife in beauty, and the method of pollination

Fig. 49.—Starwort (*Callitriche verna*).

Messrs. Flatters and Garnett. *See page* 237.

or adaptations to cross-pollination make it also one of the most interesting types. It is found in Australia. The only other British species is the Hyssop-leaved Loosestrife, which has flowers as inconspicuous as those of the Water Purslane, which is the third British type of the order Lythraceæ.

The order consists of about three hundred and sixty species and twenty-one genera, which are found in all parts of the world except the coldest regions, but the exotic ones are mainly tropical.

Trees, shrubs, and herbaceous plants are represented in this order.

The branches are usually square in section. The leaves are opposite or in whorls, entire, simple, without stipules; or, if present, they are very small.

The flowers are regular, or zygomorphic, or irregular, in racemes, cymes, or panicles. The parts of the flower are in fours, fives, or sixes. The calyx is gamosepalous, inferior, ribbed, with eight to twelve lobes, alternate, with as many teeth (the epicalyx), and tubular or bell-shaped. The calyx-tube is hollow, and persistent. The sepals are valvate, and there may also be an epicalyx made up of combined stipules (as above).

The corolla is polypetalous, with three to six petals, crumpled in bud, or absent in Water Purslane. The petals are inserted on the calyx-tube. The stamens are perigynous, inserted low down on the axis or calyx-tube, twice as many as the sepals as a rule, six or twelve, or less, or indefinite, and are equal or

unequal, turned inwards in the bud. The anthers are versatile, and often bent back. The disc is annular, one-sided, or wanting. The pistil of two carpels is syncarpous. The ovary is superior, two- to six-celled, with a simple, straight, or wavy style, and a pin-headed stigma. At the base it is two- to six-locular. The ovules are numerous. The fruit is usually dry and a capsule, enclosed in the calyx-tube, two- to six-celled, or one-celled.

The flowers are heterostylic in the Purple Loosestrife (*q. v.*).

The capsule opens by valves along the centre, and the seeds are numerous, and float in water.

The plants often possess astringent properties or are acrid. The Pomegranate has an astringent bark. Henna is derived from *Lawsonia inermis*, used by women in Egypt to stain the nails an orange colour, and for dyeing Morocco leather reddish-yellow.

The group is related to the Willowherb group, Myrtles, and to the Mare's Tail group, to Rosaceæ in the insertion of the stamens.

PURPLE LOOSESTRIFE (*Lythrum Salicaria*).

One of our most beautiful wild flowers, the Purple Loosestrife does not belong to the same group (Primulaceæ) as the Yellow Loosestrife, but is more nearly related to the Willow-herbs, being placed in a family by itself.

Common throughout the British Isles, it is found also in the Channel Islands.

River-banks, ditches, marshy places or damp places generally are the spots in which to find this plant. It is found in the freshwater aquatic formation, in the reed-swamp association in the lowlands. It is also found in the fen association in river-valleys in East Anglia.

The habit is erect, the rootstock creeping, the stems stout, slightly branched, either smooth or softly downy, four- to six-angled or winged. The leaves are opposite, or in threes or fours, stalkless, clasping the stem below, acute, lance-shaped, willow-like (hence *salicaria*), entire, heart-shaped at the base, the upper ones not so long as the flowers, or longer.

The flowers are purple, or blood red (hence *lythrum*, gore), in whorls in a spike, with small or no bracts. The calyx-teeth are awl-like, twice as long as the short inner ones, twelve-ribbed. The petals are narrow to oblong, wrinkled. The capsule is ovoid. There are twelve stamens, and the styles are of three different lengths in the three types of flower.

The flowers are in bloom from July to September. The plant is a herbaceous perennial, 2 to 5 ft. in height.

The flowers contain honey, and the stigma and anthers ripen together, but the flowers, being trimorphic, cross-pollination is rendered possible by the heterostylic adaptation. The style is long, intermediate, or short. The filaments differ also, as do the pollen-grains. The long-styled form is hairless,

slender, with narrow leaves and bright flowers; the short-styled form is larger, coarser, very downy, with dull purple flowers. The three forms have the following arrangements: a long style with medium stamens, medium-sized yellow pollen, and short stamens with small yellow pollen; medium style with long stamens and large green pollen, and short stamens with small yellow pollen; a short style with long stamens and large green pollen, and medium stamens with medium yellow pollen.

By these arrangements eighteen modes of cross-pollination are rendered possible. The seeds of the three forms, long, medium, and short styled, differ in number, being in the proportion of 100, 121, 142. Unless the flowers are cross-pollinated by insects the plant does not set seed. Being a conspicuous flower with honey it is much visited, however, by bees, humble-bees and flies, which alight on the stamens and pistil. The long-styled form must be fertilised with either of the long-stamened forms for the most perfect results, and is imperfectly pollinated by the shorter-stamened forms or by its own short stamens. In the two former cases pollination is legitimate, in the four latter illegitimate, and of the eighteen modes of pollination possible six are legitimate, twelve illegitimate.

The fruit or capsule opens down the centre of each valve and bursts irregularly. The seeds are small, numerous, plano-convex, yellow, testaceous, nearly smooth, and float in water.

The names by which this plant is sometimes known are Purple Grass, Herb Willow, Long Purples, Purple Loosestrife, Red Sally, Soldiers, Spiked Willow Herb.

LYTHRUM SALICARIA.—*In Fig.* 50 *the leaves are seen to be opposite. In the flowers the stamens are exserted.*

32. THE WILLOW-HERB GROUP.

Amongst the Willow-herb group or Onagraceæ are placed the exotic Fuchsias, which have become so well acclimatised to this country that in the Isle of Man, South and West of Ireland, Cornwall and the Scilly Islands they grow in the open and attain the size of hedgerow shrubs, being often used in gardens for a fence. They are natives of Central and South America, and New Zealand, or the Southern Hemisphere. It is noteworthy that many plants of Great Britain and other countries in the Northern Hemisphere are found in the Southern Hemisphere, as in New Zealand and the Falkland Islands, the two zones of vegetation being largely similar in main types, though less so in the component species.

Save for this genus the Willow-herb group is characteristic of the Northern Hemisphere. There are about four hundred and seventy species and thirty-six genera.

These plants are mainly perennial. A few exotic types are shrubs or trees. The Willow-herbs are propagated vegetatively by stolons forming rosettes.

The leaves are either opposite or alternate, or in whorls, and usually entire. As a rule there are no stipules.

The flowers are regular, solitary, in axils of the leaves, or in racemes, spikes or panicles. They are hermaphrodite and zygomorphic as a rule. The parts of the flower are generally in fours, but sometimes either in twos, threes or fives. A characteristic feature is the inferior ovary, the axis being continued above into the calyx-tube. The calyx is gamosepalous, superior, with two to four lobes, and is valvate in bud. The coralla is polypetalous and consists of four or two petals, which are usually twisted in bud. The flowers are apetalous in *Ludwigia*. The petals are perigynous, fugacious, soon falling. The disc is epigynous, and forms a lining to the calyx-tube. The stamens are two, four or eight, and are perigynous, in one or two series, and are sometimes declinate. The anthers are oblong and the pollen is triangular. The pistil is syncarpous, inferior, and consists of four carpels. The ovary is four- or six-celled. The style is slender, with a knob-like stigma, entire or four-lobed. The fruit is a capsule as a rule, loculicidal, but may be a drupe, nut, or a berry. The seeds are single or numerous, and are practically all exalbuminous, papillose or hairy.

The flowers are adapted to bees or butterflies and moths, some, as the Evening Primrose, opening at night. The anthers of most open first. In the exotic *Lopezia coronata* the flowers are explosive.

The seeds are provided with a tuft of hairs and wind-dispersed, or in *Circæa* the fruits are hooked and dispersed by animals.

Many ornamental garden flowers are included here, *e.g.* *Clarkia*, *Œnothera*, *Fuchsia*.

BROAD SMOOTH-LEAVED WILLOW-HERB (*Epilobium montanum*).

Almost every wayside hedge is lined with scattered clumps of this choice wild flower in June and onward into late summer.

Common in all parts of the British Isles, in the Lake District it rises to an altitude of 1700 ft. or more. It is also a native of the Channel Islands.

Banks, hedges, roadsides, ditch-bottoms, walls, cottage roofs, woods, waste and cultivated ground are amongst the more usual habitats of the plant. It may often be found in the garden. The variety of habitat is largely due to the mode of dispersal of the seeds, which is effected by aid of the wind. This, indeed, is a characteristic of the plants that are so dispersed.

It is found on sandy soil in the dry woods formed by the sessile and pedunculate oaks, and in other woods where the sessile type of oak is predominant, on siliceous soils.

The plant is erect in habit with autumn runners or offsets, which are short and sometimes stalkless, underground and fleshy, or subaërial with leaves forming a rosette, more or less erect. The stems are

simple or a little branched, round in section, not angular, and hairless or sometimes hoary. The leaves are mainly opposite, without hairs, or the edges and veins downy, oblong to ovate, acute, with a rounded base, toothed, usually stalkless, but sometimes stalked. Occasionally the leaves may be in whorls of three.

The buds are ovoid, drooping, or erect. The flowers are pale purple or white. The sepals are lance-shaped, and the calyx crowns the downy ovary, which tapers into a stalk below. The petals are twice as long as the sepals, or equal when deeply notched. The stigma is four-cleft, the lobes oblong, spreading, not turned back. The capsule is finely downy, the seeds tubercular, oblong, blunt both ends, or narrowed below.

The flowers are in bloom in June and July. The plant is a herbaceous perennial and 6 in. to 2 ft. in height.

The stigma and anthers ripen at the same time. The flowers do not open wide. Honey is secreted on the summit of the ovary. When it is wet the ovary is drooping and the petals close so that pollen and honey are protected from the rain. The anthers open close around the stigma when the latter is ripe so that self-pollination is possible. But the flowers are visited by insects so that there are equal chances of cross-pollination.

The capsule splits open from above downwards between the valves and along the centre of each, the

central axis having the seeds attached to it. These are provided with a tuft of hairs, and being small are easily blown to a distance by the wind.

EPILOBIUM MONTANUM.—*The leaves are seen to be shortly stalked in Fig. 51. There is one flower not yet fertilised showing the closed petals and the inferior ovary. The capsules are beginning to dehisce and curl open.*

EVENING PRIMROSE (*Œnothera odorata*).

As the English name denotes, the Evening Primrose is one of those sweet-scented nocturnal or crepuscular flowers that bloom in the evening, having as a rule their flowers closed during the day. This is one of the numerous adaptations of flowers to the habits and requirements of those insects that are best fitted to enable them to prolong the race in the most perfect manner by the carrying of the pollen of one flower to the stigma of another flower. In this work nocturnal moths play an interesting part.

There are two Evening Primroses in this country, both of American origin, which are more or less established. Others have been found recently which are aliens, and, since the work of De Vries upon mutations, numerous additional species have been distinguished. *Œnothera lamarckiana* is, in fact, one parent in the line of a number of these incipient species or mutations.

In England this species has been long established on the Cornish, Devon, and Somerset coasts, and in

Jersey. The plant is a native of Patagonia. It is regarded as a garden escape.

The habitat is sandy waste places and sea coasts, as at Plymouth.

The habit is erect. The stem is purplish, branched, with spreading hairs. The leaves are hardly stalked. The radical leaves form a rosette, and are linear to lance-shaped, toothed. The stem-leaves are ovate to lance-shaped, narrowed at the point, wavy. The leaves are bright green in colour. The lower leaves are nearly flat, with green or purple nerves.

The flowers are large, bright deep yellow, becoming dull orange-red. The petals are longer than the stamens. The corolla has four petals, the calyx four sepals. The anthers are versatile and club-shaped. The capsule is long, cylindrical, downy, 2 in. in length.

The flowers bloom in July up to September. The plant is biennial or perennial, and may vary from 2 to 5 ft. in height.

The flowers contain honey, which is concealed and protected by hairs. The anthers are ripe in advance of the stigmas. The corolla is deep, and only long-tongued insects can reach the honey. The flowers open in the evening, and are pollinated by night-flying moths attracted by the sweet scent. During the day they may, if open, be visited by long-lipped bees. The flowers only last two nights. The stigma ripens on the morning of the second day. Insects alight in the centre of the flower, or hover over it, the eight stamens

The Author. FIG. 51.—SMOOTH-LEAVED WILLOWHERB (*Epilobium montanum*), in fruit. *See page* 245.

The Author. FIG. 52.—EVENING PRIMROSE (*Œnothera odorata*). *See page* 247.

and four-fid stigma standing in the centre, being long and erect. The pollen-grains are triangular, connected by glutinous hairs, and they therefore cohere in a mass.

The capsule splits from above downwards by four valves, and the seeds are on the axis, and blown away by the wind.

The Evening Primrose is occasionally in bloom during the day, but usually opens at night.

> "You Evening Primrose, when day has fled,
> Open your pallid flowers, by dews and moonlight fed."

The name Evening Star has also been applied to it.

The flowers are said to give a loud, popping noise when closing again about the time of sunrise.

ŒNOTHERA ODORATA.—*The flowers in Fig.* 52 *are shown in the axils of the leaves, borne on long peduncles, with the four sepals reflexed in one case in the bud, exceeding the corolla, which is longer at length.*

ENCHANTER'S NIGHTSHADE (*Circæa lutetiana*).

Why this plant is named Enchanter's Nightshade is not clear. It grows in the depths of woods. The name was given to the Mandrake by the Greeks and transferred to this plant, and in the case of the latter was considered appropriate because the root was used, it is said, to prepare a love philtre, Circe being an enchantress.

The Enchanter's Nightshade is common through-

out the British Isles, though rarer in Scotland, ascending to 1200 ft. in Yorkshire. It is found also in the Channel Islands.

Damp woods, hedge banks, and shady places are the habitats of this plant. It occurs in damp oak-woods on clay and loam, on siliceous soil in woods made up of the sessile oak, and in beechwoods on a chalky soil.

The habit is pyramidal, erect, from a creeping root-stock. The stem is erect or rather prostrate, rooting at the base, round in section, more or less simple, glandular and downy, with short, white hairs. The stem is swollen at the nodes. The leaves are blunt, ovate, or heart-shaped, on long stalks, the margin wavy, coarsely toothed, thin in texture, not shining. The leaves are covered with translucent dots.

The flowers are white or pink, dimerous, with two petals, two sepals, borne on slightly branched, leafless, terminal racemes. The flower-stalks are turned down in fruit, slender, jointed at the base, spreading at first. The disc is swollen. There are no bracteoles. The petals are deeply notched, the lobes broadly inversely ovate, the calyx hairy, turned back in flower, as long as the petals. There are two stamens. The style is distinct, with a thick stigma. The fruit is a capsule, pear-shaped, small, covered with hooked bristles, which form a burr-fruit. There are two seeds.

The flowers bloom from June to August. The

plant is a herbaceous perennial, and 1–2 ft. in height.

There is honey in the flowers on a fleshy disc at the base of the style. The two stamens are at first distant from the stigma, and insects use them as an alighting place. Before they curl over, the flower is adapted to cross-pollination by insect visitors. The insect alights on the style, and dusts its underside with pollen from the stamens, which it uses as a support. An insect may also alight on the stamens and drag the style down so that it touches its ventral surface, already dusted in all probability with pollen from a previous flower. Thus cross-pollination is more or less usual. In the absence of insects self-pollination may occur, but does not seem to be effective. The insect visitors are mainly flies.

The fruit is a burr fruit covered with hooks, which are adapted to dispersal by animals. The hooks catch in the wool or hair of passing animals, and the fruits easily break off the stalks, and are carried away to be pressed in the soil when the animal lies down, and are thus carried to a distance.

This plant is also called Mandrake, Bindweed, Nightshade.

Of Circe it is stated that—

> "She changed his form, who could not change his heart,
> Constrain'd him in a bird, and made him fly,
> With party-colour'd plumes, a chatt'ring pie"—

in allusion to her changing of Ulysses' companions into birds.

CIRCÆA LUTETIANA.—*The opposite, broad, cordate leaves are shown in Fig.* 53, *also the flower-stalk with some fruits still remaining, the rest having, perhaps, been broken off, having caught in the wool or fur of animals.*

33. THE WHITE BRYONY GROUP.

Only one plant is found in the British Isles which is a member of the important Order Cucurbitaceæ.

A characteristic of this group is the climbing habit, as seen in the common White Bryony, having tendrils or metamorphosed leaves. There are about six hundred and fifty species and eighty-seven genera, which are cosmopolitan, but the exotic forms are found mainly in the tropical regions.

The Cucurbitaceæ include annual or perennial, herbaceous plants. The leaves are alternate, without stipules. The tendrils are simple or branched.

The flowers are unisexual, rarely hermaphrodite, and usually cymose. They are regular, with parts in fives. The stamens and pistils are in separate flowers on the same plant, when the plant is monœcious, or on different plants, when the plant is diœcious. The calyx is gamosepalous, superior, with five lobes, valvate in bud, and is united with the corolla. There are five petals, inserted on the limb of the calyx, and distinct or united below, valvate or induplicate. The three or five stamens are more or less united, or distinct. The anthers are adnate to their filaments. They open inwards, and are one- or two-celled. The

The Author. FIG. 53.—ENCHANTER'S NIGHTSHADE (*Circaea lutetiana*), in fruit. *See page* 249.

FIG. 54.—WHITE BRYONY (*Bryonia dioica*) AND CLEAVERS (*Galium Aparine*).
G. B. Dixon. *See page* 253.

ovary is inferior, three-celled. The stigmas are of the same number as the carpels, and the styles are simple or forked. The fruit is a berry, one-celled, with many seeds. In the Melon and Cucumber it is fleshy, and a pepo when a berry-like fruit in some foreign types. The seeds are flat, with a leathery, hard seed-coat.

The order is probably nearly related to the Harebell group. It has been compared also with the Passion-flower group, or the Begonia or Elephant-ear group, or the Loasaceæ.

Many of these plants have bitter or even poisonous principles.

The Melon, Gourd, etc., have saccharine, nutritious properties. The Colocynth, Bottle Gourd, and Bryony are bitter in principle.

Here are included also the Water Melon, the Cucumber, Cantaloups, Market Melon, Sucrins, Winter Melons, Melon Pumpkin, Pumpkin, Vegetable Marrow.

The Colocynth and Bottle Gourd are poisonous. The Squirting Cucumber is also very poisonous, the mere act of carrying it in the hand being said to have deleterious effects.

White Bryony (*Bryonia dioica.*)

There are two Bryonies, one a member of the Pumpkin family, which includes *Cucurbita Pepo*, and the vegetable marrow a variety of it. The other, the Black Bryony, is a Monocotyledon, with net-veined

leaves, a member of the Yam family, or Dioscoraceæ. Both are diœcious plants, that is, with unisexual flowers, the male flowers on a different plant to that bearing the female. Both have twisted underground rhizomes, which have been employed as a substitute for mandrake or *Mandragora*.

As a diœcious plant White Bryony is dependent upon insects for pollination, and cannot be self-pollinated. The type of insect which pollinates it on the Continent is not common in this country. The White Bryony does not grow in Scotland or very largely in Wales, and it is in those districts that these insects are scarce. The correlation between insect distribution and that of certain plants is similar in other cases where a plant is specially adapted to a particular type of insect.

The White Bryony is an English plant, not found in the North of England. It is found in the Channel Islands, but does not occur in Ireland.

The habitat is hedges, thickets, and it is abundant on chalky soils, on chalk scrub, etc.

The plant is a climber, with sensitive, simple or branched, spirally twisted tendrils, which revolve, and may interlock or become released. The tendrils are modified leaves. The rootstock is thick, tuberous, fleshy, branched. The plant has a disagreeable, milky juice, and when dry a sickly odour, perhaps attractive to flies. The annual stems climb to a great height, and are slender, angled, annular. The plant is rough, with very small hairs. The leaves are stalked, palmate,

heart-shaped, the lobes five to seven, broad, deep, angular, wavy, coarsely toothed, the middle one the longest, rough both sides, with hard points.

The flowers are unisexual, the plant being diœcious, the male flowers being in stalked racemes or corymbose cymes, several together, pale yellow, the corolla broadly bell-shaped; the females, in umbels, are smaller, two together, wheel-shaped, the ovary globular, smooth, with a two-cleft stigma. The corolla is hairy, the calyx in the female flowers half as long. The berries are red when ripe, with flat, nearly round seeds.

The flowers bloom from May to September. The plant is a herbaceous perennial, and is a climbing plant, 5 to 10 ft. in height.

The honey lies concealed by the disc or receptacular tube above the ovary in the female. In the male flowers it can be reached between the stamens. The corolla is gamopetalous, which is unusual in the Calycifloræ. The stamens are fixed on the lower part of the corolla and the honey is protected by the base of the stalk. The stamens are wavy and peculiar in shape, and dust an insect both sides and above, and the anthers being gummy the pollen readily sticks. Being diœcious, insects must pollinate the plant, and where it grows it usually sets seed, so that this seems to be generally the case. But, as has been said, the insects suited to it are rare in some parts, and where they are absent so is the White Bryony.

The berry is dispersed by birds, but is poisonous, and children have died from eating them.

Bryony is from bruo, turn round, in allusion to the climbing habit. The tendrils project in a horizontal manner at first; on coming in contact with an object the curved tip, by a process called circumnutation or bowing round, forms a series of coils. These are partly turned one way, partly in the opposite direction, with an equal number of coils in each. This contrivance ensures the strain shall not be too great in one direction. The plant is loosely coiled, and has a certain amount of play to allow for wind, etc.

White Bryony is called Bryon, Bryony, Red Bryony, Cowbind, Cow's-lick, Cucurd, Elphamy, Fellon-berry, Grapewort, Hedge Grape, Wild Hop, Isle of Wight Vine, Mandrake, Murrain Berries, Wild Nep, Poison-berry, Snake-berry, Tetter-berry, White Vine, Wild Vine, Wood Vine.

The Bryony was called Wylde nepte in the fourteenth century, and the juice was employed in a drug called Dwale, used as an anæsthetic.

The thick root was used in place of Mandrake. The plant is poisonous, acrid, or blistering. It has cathartic properties, and has been used for dropsy.

A dye has been obtained from the red berries.

The Bryony, according to Gerard, was used in place of Mandrake, and he says that "the idle drones that have little or nothing to do but eate and drinke, have bestowed some of their time in carving the roots

of Brionie, forming them to the shape of men and women; which falsifying practice hath confirmed the errour amongst the simple and unlearned people, who have taken them upon their report, to be the true mandrakes."

Conway relates a story about Bryony and its substitution for the Mandrake. He says—"Thus the author of 'Secrets du petit Albert' (Lyons, 1718) says that a peasant had a Bryonia root of human shape, which he received from a gipsy. He buried it at a lucky conjunction of the moon with Venus in Spring, and on a Monday in a grave, and then sprinkled it with milk in which three field-mice had been drowned. In a month it became more human-like than ever. Then he placed it in an oven with Vervain, wrapped it afterwards in a dead man's shroud, and so long as he kept it, he never failed in luck at games or work." The same author says that he saw a figure owned by a rich Jew, which had a human face on a hen's body. The monster lived for a time on worms, and after death its potency continued. The German stories are very curious. One of them relates that a horse-dealer of Augsburg once lost a horse, and being poor, wandered in despair to an inn. There some men gave him an Alraun (mandrake), and on his return home he found a bag of ducats on his table. His wife, becoming suspicious, extorted from him the confession that he had some potent charm, and she induced him to return with it to the men, but they could not be found. In

the night the wife opened her husband's box, and finding a purse, opened it, whereupon a black fly buzzed out. Soon after the house took fire, and was burned, and the horse-dealer killed both his wife and himself.

The German poet Rist relates that he saw an Erdmann made with great pains, and more than a century old, which was kept in a coffin. On the coffin was a cloth, on which was a picture of a thief on the gallows, and a mandrake growing beneath it.

The following lines relate to the use of Bryony as Mandrake:

> "Witches which some murther do intend,
> Doe make a picture and doe shoote at it;
> And in that part where they the picture hit,
> The partie's self doth languish to his end."

BRYONIA DIOICA.—*The characteristic foliage is shown in Fig. 54, where the coiled tendrils are also distinctly evident clasping surrounding herbage. The flowers shown are male flowers, in a loose raceme.*

34. THE HEMLOCK GROUP (SUMMARY).

(*Introductory Volume, p. 111.*)

As types of the order Umbelliferæ, Beaked Parsley and Angelica were described in the Introductory Volume. In this volume White Rot, Eryngo, and Knotted Hedge Parsley are described.

There are three divisions depending on whether the umbels are simple or compound, or in the second

case according to whether the primary or secondary ridges are more prominent.

In the first division, of which the White Rot is typical, the fruit is flattened laterally and the commissure is narrow. In the Sanicle group the fruit is more or less round in section, is flattened dorsally, and the commissure is broad. Eryngo is typical of this group, which includes also *Astrantia* and Sanicle.

In the division in which the umbels are compound the ridges are nearly equal, or the primary ones are most prominent.

Of the group which has the fruit flattened laterally with a narrow commissure, Beaked Parsley is typical. It includes also Hemlock, Alexanders, Hare's Ear, Caraway, Stone Parsley, Horsebane, Goutweed, Burnet Saxifrage, Pig-nut, Cicely, Venus Comb, etc.

In the group in which the fruit is round or ovoid, not flattened laterally, with a hard commissure and distinct lateral ridges, rarely winged, the type selected is *Angelica*. It also includes Fennel, Coriander, Samphire, Water Dropwort, Fool's Parsley, Sulphur-wort, Lovage, etc.

In the group in which the fruit is much flattened dorsally, with the lateral ridges broadly winged and short, stout styles, the following are included: Parsnip, Hogweed, and *Tordylium*. In the third division Knotted edge Parsley is the type selected. It also includes the Wild Carrot, and perhaps Coriander may rather belong to this.

There are fourteen hundred species of Umbelliferæ

and about one hundred and eighty genera which are found in all parts of the world, but principally in the N. *Temperate regions*.

They include herbaceous plants with the internodes hollow as a rule and stout stems. The leaves are alternate, pinnate, and compound, rarely simple, as in White Rot. The leafstalk is swollen below, as in *Angelica*. There are no stipules.

The inflorescence is a simple or compound umbel, giving the name to the order, with an involucre of bracts in a whorl below the primary umbels, and bracteoles, forming involucres, below the secondary umbels. The simple umbels are cymose.

The flowers are small, regular, hermaphrodite, epigynous. The calyx is gamosepalous, and superior, five-lobed or entire, the odd sepal posterior. The corolla consists of five petals inserted on an epigynous disk, the tips often bent inward.

The stamens are five, at the base of the disk, epigynous, with the anther-stalks bent inwards, the anthers being versatile and opening inwards. The disk is epigynous on the top of the ovary, prolonged above into two short styles. The latter are erect, or bent back with blunt stigmas. The pistil is syncarpous, and the ovary consists of two carpels and is two-celled. The fruit is a cremocarp, consisting of two mericarps adnate to, or pendulous from, an entire or split carpophore. The cremocarps are separated by a commissure and indehiscent. The carpels bear raised ridges, between which are

oil-glands or vittæ. These features are important in classification. Sometimes the mericarps are winged.

If the division or suture between the mericarps is in the longest diameter of the cremocarp the fruit is dorsally compressed, and laterally when the suture is in the shortest diameter.

The disk secretes honey, which is freely exposed, and the flowers are much visited by insects, especially flies. The anthers ripen first.

The fruit is a schizocarp, which splits down the septum between the carpels. Some are winged and dispersed by the wind as in Hogweed, or hooked as in *Daucus* and dispersed by animals.

The group includes many useful plants.

MARSH PENNYWORT (*Hydrocotyle vulgaris*).

The English name is a clue to one of the most distinctive features of this plant, the rounded leaves like a penny as in the case of Navel-wort. Indeed the plant shows itself mainly by its leaves, the flowers, not always produced, being buried below amongst the leaves. The first Latin or Greek name also indicates its aquatic propensities, and refers again to the cup-like leaves, though as a rule they are flatter than in the Navelwort. But the peltate leaves distinguish it from all other Umbellifers.

The plant is also called White Rot, apparently because of the white, creeping stems, like the creeping hyphæ of a fungus.

There are few counties in which this Umbelliferous plant does not grow, and in the Lake District it is found at an altitude of 1000 ft. It is also found in the Channel Islands.

The habitat is marshes, bogs, ponds, lakes, and the plant is a moisture-loving species. The plant occurs on low-lying clayey soils where there is an association of rushes in wet meadows. In siliceous wet grassland it is found where there is an association of the purple moor grass, with Bog Violet, Lesser Spearwort, Sundew, Butterwort, Cottongrass, etc. It is found in the fen formation, on grass moor in upland moors, and in dune marsh associations.

The plant is creeping in habit. The stem is slender, white, sometimes floating, when it is more truly aquatic. The stem roots at the nodes, with small tufts of leaves and flowers. The leaves are shield-shaped, rounded, scalloped or lobed, with nine veins, and the long, hairy stalk arises from the centre beneath.

The florets are borne in a minute umbel in the axils, shortly stalked, the flower-stalks shorter than the leaf-stalks. The flowers are white or pinkish-green, in a single, terminal head, or in two or three whorls, with three to six florets. The bracts are very small, triangular, concave. The umbels may be proliferous in the centre and bear a second head.

The fruit is small, flat, smooth, the carpels being covered with resinous points, with two ridges on each face. There are no vittæ.

FIG. 55.—PENNY WORT (*Hydrocotyle vulgaris*).
Messrs. Flatters and Garnett. *See page*

W. E. Mayes. FIG. 56.—SEA HOLLY (*Eryngium campestre*). *See page* 263.

The flowers bloom from May to August. The plant is a herbaceous perennial, and is creeping.

The honey is exposed. The anthers open in succession, but before the last are ripe the stigma matures, so that self-pollination occurs. The pollen is pale yellow, and forms a pyramid.

The fruit consists of achenes or schizocarps, which when ripe are detached from the carpophore.

White Rot is known in different districts by the following names: Fairies' Table, Farthing Rot, Flowkwort, Penny Grass, Rot Grass, Sheep-killing Penny Grass, Shilling Grass, Penny Rot, Marsh Pennywort, Sheep-killing, Sheep-rot, Sheep's-bane, Water-cup, Water Rot, White Rot.

HYDROCOTYLE VULGARIS.—*The Fig.* 55 *shows the characteristic habit, the roots at the nodes, the peltate leaves, and the minute axillary umbels of flowers or fruit.*

FIELD ERYNGO OR SEA HOLLY (*Eryngium campestre*).

In having the florets arranged in heads, not umbels, with spinous bracts, resembling Holly in this character, the Sea Hollies differ from other Umbellifers.

The species is not so maritime as the common Sea Holly. It occurs in many parts of Britain, or England, and is considered to be a recent introduction. But it has been regarded as wild in Kent. It occurs in Ireland and the Channel Islands as an introduction.

The habitat is waste places, fields and roadsides, as on the Watling Street in Central England.

The habit is tufted or cæspitose, forming a dense bush. The stems are thick, the whole plant pale green. The radical leaves are ternate, or two or three times divided nearly to the base, the lobes lance-shaped, wavy, coarsely toothed, stalked, spinous, the stem-leaves clasping, pinnate, with three to five leaflets. The leaf-stalks are thick, channelled, half round in section.

The florets form a cymose head, and are numerous, small, purplish or white, the involucral leaves lance-shaped, spinous, pinnately toothed, the scale within the heads narrow, entire. The fruit is ovoid, and the seeds are flat.

The flowers are in bloom in July and August, and the plant is a herbaceous biennial, 1 to 2 ft. in height.

The honey is concealed and secreted by a disk, which is ten-rayed, at the base of the flower. The petals are bent over and protect the honey. The flowers are conspicuous and rendered more so by the whorl of bracts, which are coloured and often amethystine. The turned-down petals and stamens are close together, but an insect can push them aside. The flowers are visited by bees. The anthers ripen before the stigmas so that cross-pollination is the rule.

The fruit is not adapted to wind-dispersal, but the fruits are schizocarps, and may fall when ripe a little distance from the plant.

The leaves are coated with wax—an adaptation to enable the plant to resist dry conditions. In the maritime form they are glaucous. The spinous leaves and involucral bracts are an efficient protection to the plant, serving it in the same stead as the spines in the thistle to prevent browsing animals from feeding on it. They are also an adaptation against drought.

Daneweed, Hundred Thistle, Hundred-headed Thistle, Watling Street Thistle, are other names for this plant.

ERYNGIUM CAMPESTRE.—*In Fig.* 56 *the clasping opposite stem-leaves armed with prickles are well shown, as also the spinose involucre and the cyme-like head of flowers.*

KNOTTED HEDGE PARSLEY (*Caucalis nodosa*).

In this prostrate trailing plant we have a good example of an adaptation to the habitat. The Upright Hedge Parsley grows at the base of bushes by the wayside, not often on banks. This plant is common on slopes, and is thus specially fitted to creep over the surface. If erect it would not so well cope with the force of the wind, which is stronger in such situations than in the habitat of the upright form. It conforms itself, moreover, to the surface, creeping in and out over the rugosities or uneven or convex sides of such slopes.

The Knotted Hedge Parsley is found throughout the British Isles and in the Channel Islands. It seems

to be more frequent in the south than the north, and in Ireland.

The habitat is dry banks, roadsides, waste places, and cornfields. This plant grows often in association with Corn Parsley.

The habit is creeping or prostrate, then ascending and wide-spreading. The stem is slender, wavy, angled, solid, rough, with short, stiff hairs. The leaves are twice pinnate, deeply divided almost to the base, the leaflets small, narrow-pointed. The lower leaves may be twice pinnate, the upper pinnate.

The florets are regular, pink, small, borne on small, nearly round, simple umbels or little heads, which are nearly stalkless, dense, lateral, opposite a leaf, and composed of two to three stout, hardly distinct rays, or a simple cluster. The female florets are nearly stalkless. There are no involucres. The fruit is smaller than in other species; the outer fruits are covered with straight or hooked bristles, those on the inner part of the umbels merely tubercled. The spines are spreading, hooked or barbed.

The flowers are in bloom between May and July, and the plant is a herbaceous annual, 6 to 18 in. in length, rarely ascending or erect.

The flowers contain honey, and the anthers ripen first. The species of Caucalis frequently have male and complete flowers on the same plant, but some are female, and the plant is distinctly polygamous, the arrangement and distribution of the sexes being variable.

The fruit is in part a burr fruit and thus dispersed partly by animals, but the inner fruits are adapted to germination close at hand and the tubercles serve to retain the fruit, showing a division of labour in this respect.

CAUCALIS NODOSA.—*Note in Fig.* 57 *the long, trailing stems, with flowers and fruit in small umbels at the nodes, and the pinnate leaves.*

35. THE IVY GROUP (SUMMARY).

(*Introductory Volume, p. 117.*)

The only British plant which is a member of the order Araliaceæ is the Ivy, already described in the Introductory Volume. Sometimes the Tuberous Moschatel is placed in the same order.

The order consists of some four hundred species and fifty-one genera, which are found chiefly in the Tropics, the Indo-Malayian region, and America.

The members of this group are trees and shrubs, either erect or climbing. Some of them, as Ivy, have a twining habit, climbing by aid of aërial, root-like organs.

The leaves are often alternate, and simple or compound, large, with stellate pubescence or down. There are small stipules, which are adnate to the leaf-stalk, or they may be absent.

The flowers are small, in umbels forming a compound inflorescence, but usually simple, thus differing from most of the Umbelliferæ, to which they are

more or less allied. But the fruit also is different, being usually succulent, not dry, and made up of more than two carpels.

The flowers are regular, hermaphrodite, epigynous, with the parts in fives, or from three to more. The calyx is superior, attached to the ovary, entire or with five lobes, which are very small and short, toothed, or with a limb. There are usually five petals, or four or more, often leathery, deciduous, valvate, or slightly overlapping in the bud. The stamens are five to ten, of the same number as the petals, or twice as many, inserted on the ovary, or the rim of the epigynous disc. The anther-stalks are bent inwards. The anthers are versatile and didymous. The ovary contains more than two cells, with as many styles and stigmas. The styles are free or united.

The fruit is a drupe with as many stones as carpels, with one or more one-seeded cells. The ovules are solitary and pendulous. The small embryo contains abundant endosperm.

In this group are included Aralia, often planted in gardens, and *A. ginseng* yields the Chinese drug, Ginseng, which is considered tonic and stimulant. Some of the species are aromatic.

36. The Cornel or Dogwood Group.

There are two species of Cornel found in this country, the Common Dogwood and the Dwarf Cornel, the latter being a rare species found on alpine

W. E. Mayes. FIG. 57.—KNOTTED HEDGE PARSLEY (*Caucalis nodosa*). *See page* 265.

J. H. Crabtree. FIG. 58.—CORNEL (*Cornus sanguinea*). *See page* 270

moors. To illustrate the order Cornaceæ the common Cornel is described here.

There are about eighty species of Cornaceæ and sixteen genera are recognised. They are found chiefly in the northern temperate regions, but are found in all parts of the world. The Japanese Laurel or Aucuba and *Garrya elliptica* are common shrubs in this country.

On the Continent the Cornelian cherry, *Cornus mascula*, is frequent, and is planted in this country. It is used in the manufacture of sherbet by the Turks.

The group is related to the Honeysuckle group and to the Ivy group.

Most of the Cornel group are trees or shrubs. The leaves are opposite or rarely alternate, generally entire, and with no stipules.

The flowers are small, regular, the inflorescence a terminal or axillary cyme, umbel, or head, or corymbose. In *Cornus* the flowers form a head with an involucre. The flowers are usually hermaphrodite, with the parts in fours or fives or more. The calyx-limb is superior, and small or absent, with four sepals attached to the ovary, open or valvate in the bud. The petals are four or five, at the base of the epigynous, annular disc, or top of the calyx, valvate or overlapping in bud. There are four or five stamens, inserted with the petals, and free, at the base of the epigynous disc. The anthers are adnate or versatile. The ovary is inferior, multilocular, or one- to four-

celled. There is a single style, the stigma being simple or branched. There is a single ovule in each cell. The fruit is a berry or a drupe with one to four stones, or a one- to four-celled stone, or two stones. The seeds are oblong.

In some American Cornaceæ the bark is tonic in principle, like Cinchona bark. The burnt wood of the Cornel yields good charcoal for gunpowder.

DOGWOOD OR CORNEL (*Cornus sanguinea*).

The hard character of the wood of this shrub is denoted by the Latin *cornus*, *cornu*, which means a horn, and this is the origin of the name Cornel. The second Latin name refers to the red bark of the young shoots. Parkinson said the fruit was not fit for dogs, hence, perhaps, the names Dogwood, Dog-berry.

Cornel does not grow in Scotland, being confined largely to southern and central England and a few parts of Ireland, and in Scotland it is only planted. In Derbyshire on the Pennines it occurs up to 1050 ft. or more. It is found also in the Channel Islands.

The habitat is thickets, copses and hedges. Cornel forms part of the coppice in damp oakwoods, on clay and loam, on limestone in ashwoods, on limestone scrub, on chalk scrub, and in ash-oak woods on marls and calcareous sandstones.

An erect shrub in habit, Cornel is somewhat downy, with leaves and young branches red in autumn (hence *sanguinea*), and the old bark is reddish.

The branches are straight. The leaves are opposite, ovate or oblong, blunt-pointed or acute, green both sides, stalked, strongly veined, the lateral nerves sub-basal, when young hoary or silky, with the hairs closely pressed to the surface, green and smooth when older.

The flowers are creamy-white in terminal, flat, dense cymes, numerous, bractless. The calyx and flower-stalks have a mealy down. The petals are lance-shaped. There is no involucre. The fruit is a small, rounded drupe, black, or dark purple, and bitter.

The flowers bloom in June and July. The plant is a deciduous shrub, and 5 to 6 ft. in height.

Honey is secreted by a fleshy ring at the base of the style, and is fully exposed and more accessible to short-lipped insects than long-tongued bees, which come for pollen. The anthers and stigma ripen simultaneously. The anthers open inwards and are level with the stigma a little distance away. An insect touches the stigma with one side and the anthers with the other side. The result in going from flower to flower is to bring about cross-pollination. A few creeping insects may cause self-pollination. The stamens rise up and turn inwards, and if insects do not visit the plant it is self-pollinated. Stigmas of neighbouring flowers may touch the anthers and so cross-pollination also may follow in this way. Many insects, beetles, flies, wasps, etc., visit the flower.

The berry is a drupe, which is largely dispersed by thrushes.

In the days of Homer the fruit was a food for swine. Spear shafts and bows were fashioned out of the wood. The Dogwood is a good hedge shrub and much planted. The wood, being very hard, was formerly used for cog-wheels, also for butchers' skewers (hence Prickwood) and ram-rods. The charcoal yields the best gunpowder.

Oil is contained in the berries and soap was formerly manufactured from them.

The following names have been applied to Cornel: Bloody Twig, Catteridge-tree, Cat-tree, Cornel, Female or Wild Cornel, Corne-tree, Dog-berry, Dog-cherry, Dog-Timber, Dog's-berry Tree, Dog-tree, Dogwood, Female Cornel Tree, Gadrise, Gaiter-tree, Gaitre-berries, Gaten-tree, Gatten-tree, Gatter Bush, Gatteridge, Houndberry Tree, Hound's Tree, Prick Timber, Prick Tree, Prickwood, Skewer-wood, Skiver-wood, Widbin. Some of these refer to the use of the twigs as skewers, etc., as in the case of Spindle tree, some of the names referring to both trees.

There was a superstition that if the sap of Dogwood was absorbed in a handkerchief on St. John's night it would secure the fulfilment of every wish.

CORNUS SANGUINEA.—*In Fig.* 58 *note the characteristic leaves, the deeply-veined upper surface of the leaf, the flowers in different stages, some with anthers and stigma projecting, others with the stigma only.*

CHAPTER III

GAMOPETALÆ (FLOWERS WITH TUBULAR COROLLA) (= MONOPETALÆ OR COROLLIFLORÆ)

ALL the members of this sub-class, with some exceptions, agree in having a perianth in two whorls, or dichlamydeous, and the corolla tubular. The petals are more or less united into a two- or more-lobed corolla. This characteristic has, however, been noted as occurring in the Thalamifloræ (*vide* Chapter I), as in the Fumitory group, Milkwort group, Purslane group, Tamarisk group, Mallow group, Holly group, in Navelwort, in the Stonecrop group, in the White Bryony group.

There are some exceptions in this group to the above general rule. The petals are free in the Heath group, in the Winter green, and Bird's Nest, and in the Sea Lavender group. The corolla is absent in the Ash in the Ash group, and in Sea Milkwort in the Primrose group.

The ovary is inferior and the stamens are epipetalous in the Honeysuckle group, Bedstraw group, Valerian group, Teasel group, Dandelion group, and

the stamens are inserted on the top of the ovary in the Harebell group and Heath group. In the Brookweed amongst the Primrose group the ovary is inferior as here. In Lobelia amongst the Harebell group the stamens are epipetalous.

In a second series the ovary is superior, the stamens are epipetalous. In some Heaths they are hypogynous, however, as also in the Ash amongst the Ash group, in the Shoreweed amongst the Plantain group, and in the Sea Lavenders.

The corolla is regular. There are eight or ten stamens, rarely five or six. The anthers open, as a rule, by pores, and the ovary is four- to six-celled in the Heath group and Bird's Nest group. The stamens are four to five, opposite the corolla-lobes, the ovary one-celled, the placenta central in the Sea Lavender and Primrose groups. There are two, one, or four stamens alternate with the corolla-lobes, a two-celled ovary, and opposite leaves, except in the Bogbean, where they are alternate, in the Ash group, Periwinkle group, and Gentian group.

The corolla is regular or subregular, with four to five stamens alternate with the corolla lobes, the ovary two- to four-celled, the leaves alternate or radical, in the Jacob's Ladder group, Hound's Tongue group, Convolvulus group, Deadly Nightshade group, and Plantain group.

The corolla is irregular, rarely subregular, with two or four stamens, rarely five, with a one- to two-celled ovary, many-ovuled cells, opposite or alternate-

leaves in the Figwort group, Broom Rape group, Butterwort group.

The corolla is irregular, with two or four stamens, the ovary two- or four-celled, the cells containing one ovule, the plants, herbs or shrubs, with opposite or whorled leaves, without stipules in the Vervain group and Dead Nettle group.

37. The Woodbine Group (Summary).

(Introductory Volume, p. 123.)

In the order Caprifoliaceæ are included the Guelder Roses, Elders, Moschatel (or in the order Adoxaceæ), Woodbines, and *Linnæa.*

In the Elder group the corolla is usually wheel-shaped, regular, and the cells of the ovary contain one ovule. The style is short, with two or three branches, or there may be no style. This group includes the first three types. The Woodbine group includes the last two types, with a tubular or bell-shaped corolla. The cells of the ovary contain one, or more than one, ovule. The style is slender.

In this group there are nearly two hundred and fifty species, and these are included in eleven genera. They are found chiefly in the North Temperate regions and on mountains in the Tropics, being rare in the South. The majority are trees and shrubs, with a few herbaceous types. The leaves are simple, opposite, or decussate, usually without stipules, with pinnate leaves in Elder.

The flowers are regular, hermaphrodite, the inflorescence cymose, with the parts of the flower in fives, the odd sepal posterior.

The calyx is gamosepalous and persistent, and the calyx-limb is superior, with three to five teeth or lobes attached to the ovary. The corolla is gamopetalous, epigynous, regular or irregular, sometimes two-lipped, with five lobes, overlapping in bud.

The stamens are in one whorl, epipetalous, inserted on the corolla, of the same number as the petals, alternating with them, or four, five, eight, or ten, equal or unequal. The anthers are versatile. They open outwards in the Elders, inwards in the Guelder Roses. There is a glandular, epigynous disk, or it may be wanting, as in the Guelder Roses. The pistil is syncarpous, with three carpels as a rule. The ovary is inferior, one- to six-celled. The style is entire or six-lobed. There are one to three stigmas, which are pin-headed. The fruit is fleshy, a berry or a drupe, rarely a capsule, one- or many-seeded. The seeds are small, with a small embryo and fleshy endosperm.

The British types differ from the foreign members of the Woodbine group in the absence of stipules, except in the Elders. The group also differs from the Valerian and the Teasel groups in the compound ovary.

The Elders have been used medicinally. The Snowberry, *Symphoricarpus*, is well established in this country, and *Leycesteria* is a favourite garden

shrub. The Snowball, a variety of Guelder Rose with the florets all neuter, is also commonly planted.

HONEYSUCKLE (*Lonicera Periclymenum*).

The second Latin name refers to the climbing or twining habit of the Honeysuckle. The first Latin name was given to commemorate A. Lonicer, a German botanist of the sixteenth century.

The English name Honeysuckle is from the A.S. "kunigsuge" (the privet) and A.S. "sugan," to suck, in allusion to the honey scent and the long tubes called, like Clover florets, "suckles" by children, who suck out the honey from them.

Honeysuckle is familiar to all country dwellers, being grown frequently above a rustic porch over a cottage door. Frequently also another reminder of the woods is there, in the shape of a blackbird or mavis in a wicker cage. The peasant thus shows a fine feeling—though we may take exception to the bird's imprisonment—for the beauties of the country both as regards melody and fragrance, of which the woods breathe in spring and summer. The charms of Arcady, indeed, are endless.

There is no difficulty in finding Honeysuckle in most parts of the British Isles, and in Durham it ascends to 1500 ft. It occurs in the Channel Islands. Woods are the haunts of the Honeysuckle or Sweet Eglantine (perhaps more rightly the Sweet Briar). A climbing plant, it needs the support of other plants,

trees or shrubs, and outside a wood is rarely found, except it be in a hedgerow or in scrub.

It grows in damp oakwoods on clay and loam, on sandy soil in oakwoods where both the pedunculate and sessile oaks grow, on siliceous soils in dry oakwoods where the latter predominate, in ashwoods on limestone, and on chalk scrub.

The habit is twining. The plant is smooth or slightly downy. The stem is woody, and scrambles over bushes and trees, sometimes to a height of 20 ft. The leaves are often downy below, lobed when young, and are all distinct, blunt, oval, oblong, smooth above, downy below, the lower narrower at the base or stalked, the upper rounded, closely sessile, deciduous. The flowers are red externally, creamy white, several, in stalked cymes or glomerules, sessile above the last leaves. The tube of the corolla is long, gaping, 1½ in. long, glandular, downy. The calyx teeth are persistent.

The fruit is small, red when ripe, round. The pericarp, placenta, bracts, and axis are fleshy. The anthers are versatile.

The flowers bloom from June to September. The plant is a climbing shrub 10 to 20 ft. high.

Honey is secreted at the base of the tube, and half fills the tube, so that then short-lipped humble bees may get at it. The flowers open about 7 or 8 p.m. and are very fragrant, being vertical in bud. Owing to the long tube, however, it is especially adapted to Lepidoptera or long-tongued moths.

The flowers become horizontal. The anthers and stigma ripen together, but when the anthers project the stigma is turned downwards, and projects beyond them, and cross-pollination is thus possible. On the second day there is no pollen, the stigma is in the place of the stamens not turned down, if insects have visited the flower. An insect would touch anthers the first night, the stigma the second. Meanwhile also the corolla rises again, the lips curl up, and become discoloured and yellow by the second night. This is a sign to an insect that it is useless to visit such flowers for pollen, and they visit the more conspicuous flowers first. The flowers then become dark or dirty orange, and the tube rolls up, and the flower is no longer fragrant.

If insects do not visit the flowers self-pollination may occur. The flowers are pollinated chiefly by the Humming-bird Hawk-moth, and I have noticed that the Silver Y Moth, the Burnished Brass Moth, and the Yellow Underwing are abundant.

But the Convolvulus Hawk-moth and the Privet Hawk-moth are the more effective insect visitors.

The berries are dispersed by birds.

The honeysuckle is much cultivated as a garden shrub or climbing plant for trellis work or arbours.

Woodbine is also called Bearbine, Benewith Tree, Benwyttre, Bind, Bindweed, Bindwood, Binnwood, Bynde, Caprifole, Cernoyle, Chervell, Eglantine, Goat's Leaves, Goat-tree, Hinnisickle, Honeybind, Honeysuckle, Irish Vine, Lady's Fingers, Lily-

among-thorns, Mel-silvestre, Oodbine, Servoile, Suckle-bush, Suckling, Sycamine, Trumpet Flower, Widbin, Woodbind, Woodbine.

In Scotland branches of Honeysuckle were formerly hung up in the cowhouse on May 2nd to preserve the cattle from bewitchment.

LONICERA PERICLYMENUM.—*In Fig.* 59 *the flowers are well shown with the five stamens and in some cases the longer style and stigma, or in a few the latter is less developed.*

38. THE BEDSTRAW GROUP.

Of this group, or the order Rubiaceæ, named after Rubia or Madder, there are some four thousand and five hundred species and three hundred and fifty genera. The British types belong to the Galieæ.

They are found in all parts of the world, but a large number are tropical. Trees, shrubs, and herbaceous types are represented in the order, the latter often woody below. The stems are square in section, The leaves are entire or occasionally toothed, in whorls. The stipules are decussate, leaf-like, and are between the leaf-stalks, or between the leaf-stalks and the axis, and sometimes united to each other, and to the leaf-stalks, forming a sheath round the stem. The stipules are as large as the ordinary leaves.

The inflorescence is cymose, or a branched cymose panicle. In rare cases there are solitary, terminal flowers. The flowers are small, usually hermaphrodite, regular, epigynous, with the parts of the

J. H. Crabtree.

FIG. 59.—HONEYSUCKLE (*Lonicera Periclymenum*).

See page 277.

flower in fours or fives. The calyx is gamosepalous, the calyx-limb superior, entire or with four to five lobes, or nearly wanting, open in bud, and in some cases one sepal is larger than the others and coloured in exotic types. The corolla is gamopetalous, epigynous, regular, valvate, twisted or overlapping in bud, with four or five lobes, tubular, wheel-shaped, bell-shaped, or funnel-shaped. The stamens are epipetalous, as many as the corolla lobes, and alternate with them, four to five inserted on the tube. The anther-stalks are usually short. The anthers are didymous. The pistil is syncarpous. The ovary is two-celled, the style is two-cleft with two terminal stigmas, pin-headed or lobed. The fruit is a capsule, septicidal or loculicidal, a berry or a schizocarp, and is didymous. The seeds are ascending, with a small embryo and much endosperm.

The flowers are pollinated by insects. The honey is freely exposed or but little concealed. Flies are the chief visitors.

Rubia, especially *R. peregrina*, yields Madder. Coffee is yielded by one exotic type, Cinchona by another.

To illustrate this group Lady's Bedstraw, Squinancy Wort, and Field Madder are described.

Lady's Bedstraw (*Galium verum*).

A local name Guinea Gold admirably describes the colour of the massed flowers of the Lady's

Bedstraw, which is a familiar wayside plant almost everywhere.

From the fact that the flowers were formerly used to curdle milk the first Latin name derived from the Greek *gala* has been chosen.

In practically every county one may find this lovely wayfarer. It occurs as far north as the Shetlands, and in the Highlands it ascends to 2000 ft.

Banks, pastures, dry sandy places, often by the sea, downs, etc., are the habitats of this plant. On neutral grassland, on clay or loam, it occurs with pasture grasses, Bulbous Crowfoot, Cuckoo Flower, Grassy Stitchwort, Milkwort, Red and White Clover, Bird's Foot Trefoil, Agrimony, Daisy, Milfoil, etc. On sandy soil it is common on grass heath with Milkwort, Purging Flax, Stork's Bill, Furze, Bird's Foot, etc. It is found on limestone grassland, chalk grassland, on upland moors, on grass moor, on dune grassland, in the marram association, in the fixed dune association.

The habit is erect, with a stoloniferous rootstock, which is woody, creeping. The plant is black when dry, smooth or rough on the edges of the leaves. The stems are branched below, four-angled, prostrate or ascending. The leaves are small, linear, bristle-like, eight to twelve in a whorl, numerous, bent down, downy below, rough above, with a blunt point, channelled above, the margin bent back. These characters indicate that the plant is adapted to dry conditions.

The flowers are pale yellow, in compound, axillary and terminal, leafy cymes, which are dense and many-flowered. The flowers are sometimes green or straw-coloured, the plant sometimes hybridising with *G. Mollugo*. The panicles are small, collected into a dense spike. On sandy soil the flowers may be solitary. The petals are blunt, with a short point. The fruit is small, smooth, black, and the fruit-stalks are spreading.

The flowers bloom in June onward till September. The plant is a herbaceous perennial, varying in height from 1 to 2 ft.

The flowers are hermaphrodite or bisexual. Honey is secreted by the fleshy base of the ovary at the base of the style, adhering in a thin layer. The anthers are erect at first, and covered with pollen before the two stigmas ripen, lying close together. The stamens then become horizontal, and curve down at the end between the petals, and the styles also spread out. The stigmas may be receptive in the first stage, before they spread out. The movement of the stamens is calculated to prevent self-pollination and to promote cross-pollination. Insects carry pollen on their feet. The visitors are numerous, and being yellow the flowers are attractive to beetles, as well as flies and Hymenoptera. The flowers differ locally in size.

The fruit is didymous, the lobes one-seeded, and when ripe they fall apart near the plant.

The name Lady's or Ladies' Bedstraw refers to

the fact that the plant was formerly used as bedding. A red dye for wool is furnished by the roots, and the plant was formerly cultivated for this purpose. In Ireland the stem and leaves have been used for a yellow dye.

The plant has been used in Gloucestershire as rennet, and in the sixteenth century was called "cheese-renning." It was used in Cheshire for this purpose.

Amongst the names by which this plant is known are: A-hundred-fald, Bedflower, Yellow Bedstraw, Brum, Cheese-rennet, Cliver, Curdwort, Flea-weed, Fleawort, Gallion, Yellow Goose-grass, Hundred-fold, Joint Grass, Keeslip, Lady's Beds, Maiden-hair, Maid's Hair, Rennet, Wild Rosemary, Runnet, Strawbed.

Lady's Bedstraw was also called Maid's Hair "from its soft flocculent habit" according to Prior, "like the loose, un-snooded hair of maidens, and its yellow colour, to which, as a beauty in the hair of women such frequent allusion is made by Chaucer and other romance writers."

Another writer states that Lady's Bedstraw, formerly Our Lady's Bedstraw, or Bedstre, "may allude more particularly to the Virgin having given birth to her firstborn in a stable, with only the grass or herbs of the field for her bed.

"In fact we know that in earlier times such materials were freely used, and the soft, puffy stems of this particular plant, with its golden blossoms, would have exactly adapted it for a connection in

W. E. Mayes. FIG. 60.—LADY'S BEDSTRAW (*Galium verum*). *See page* 281.

W. E. Mayes. FIG. 61.—SQUINANCY WORT (*Asperula cynanchica*). *See page* 285.

legend with the nativity. In Germany we find the same name given to this plant."

Brand says: "In the old herbals we find descriptions of a herb entitled the 'Ladies' Bedstraw.' It appears that even so late as Henry VIII's time, there were directions for certain persons to examine every night the straw of the king's bed, that no daggers might be concealed therein. In 'Plaine Percevall, the Peacemaker of England,' printed in the time of Queen Elizabeth, we find an expression which strongly marks the general use of straw in beds during that reign: 'These high-flying sparks will light on the heads of us all, and kindle in our bed-straw.'"

GALIUM VERUM.—*In Fig.* 60 *note the whorled, linear leaves, the crowded terminal, axillary, leafy cyme, with numerous flowers.*

SQUINANCY WORT (*Asperula cynanchica*).

Many of the species of this genus Asperula have rough hairs, hence this name. As a cure for quincy or squinzy it was called Squinancy Wort, and the second Latin name refers to its choking nature—Greek, *kunanche*, dog-strangle.

One may meet with this plant in abundance in the chalk districts of this country. It does not occur in Scotland, but in England, S. and W. Ireland, and to the south of Westmorland and Yorkshire in the former.

The habitat is dry banks, chalk downs, calcareous pastures, limestone districts, dry pastures, stony and sandy places. The plant occurs on limestone grassland with such plants as Hairy Violet, Milkwort, Kidney Vetch, Horseshoe Vetch, Salad Burnet, Rockrose, Scabious, Clustered Bellflower, Marjoram, Bee Orchis, Fly Orchis, etc., on chalk grassland, with Sheep's Fescue, and on chalk pasture.

The habit is that of a trailing plant. The whole plant is practically smooth. The stems are nearly simple, hairy below the nodes, tufted, wiry, erect, or prostrate, or spreading, in patches or leafy tufts. The rootstock is stoloniferous. The root is spindle-shaped. The leaves are narrow to linear, or oblong to lance-shaped, with a blunt point, four in a whorl, rigid, bent back, not fringed with hairs. There are only two leaves in a whorl in the upper part, four in a whorl below, and the other two are reduced to stipules and opposite. The upper leaves may be lance-shaped to narrow, the middle obovate to lance-shaped, the lower obovate.

The flowers are white or lilac, in a loose cyme, or small terminal cluster. The corolla is often pink, papillose externally, white within, and is funnel-shaped, tubular below. The fruit is small, wrinkled, granulate, or papillose.

The flowers bloom in June and July. The plant is a herbaceous perennial, and is 6 to 10 in. in height.

Honey is contained in the fleshy ring at the base of the style, and fills the tube, which is 2 mm.

long. The flowers are homogamous, the anthers and stigmas being ripe together. There are two stigmas, which are close together. The stamens are attached to the corolla and bent towards the centre. Owing to this arrangement an insect more usually is dusted with pollen on leaving a flower than on entering one, so that cross-pollination is most likely, and one side of the insect is dusted with pollen while the other touches the stigma. If insects do not come to the flower pollen falls on the stigma and self-pollination follows. There are sometimes two forms of flower. In one the petals are blunt, white, and smooth, whilst in the second they are rough on the upper surface of the limb, and there is a red elliptical line, and a second red line which crosses the long axis of the ellipse, the petals being bent back into a long point. Bees and flies are the chief visitors.

The fruit is granulate, not hooked, and may fall close to the plant.

The Squinancy Wort is also called Herb of Vine, Herb Squynantyke, Quinsey-wort, Shepherd's Bed-straw, Squinancy.

ASPERULA CYNANCHICA.—*In Fig.* 61 *the stoloniferous rootstock is shown, also the linear leaves, below in whorls of four, as a rule, bent back, and above with two in a whorl. The terminal clusters of flowers are also shown.*

FIELD MADDER (*Sherardia arvensis*).

The name of a Leicestershire botanist, James Sherard, born at Bushby, who introduced Dillenius to England, is commemorated in the first Latin name of this plant.

Field Madder is common in all parts of the British Isles, but it is not so frequent in North Scotland. It is found in the Channel Islands.

The second Latin name is an indication of the habitat of the Field Madder (as is likewise the English prefix), mainly fields, especially cultivated fields, cornfields, and waste places ; but it also occurs on banks and dry pastures.

The habit is like that of Squinancy Wort, trailing or creeping. The plant is hairy. The stems are prostrate, branched, leafy, spreading from the root. The leaves are about six in a whorl, the lower small, inversely ovate, the upper linear to lance-shaped, rough along the edge, and terminating in a fine point. These last features may be of the nature of a protection to the plant.

The flowers are lilac, blue, or pink, small, in small stalkless terminal heads, or umbels, with a broad leafy involucre of seven to eight bracts. The calyx segments are four, two being divided into two nearly to the base, the teeth being lance-shaped, aciculate, accrescent, enlarged after flowering, forming a leafy crown to the fruit. The bracts exceed the flowers.

The tube of the corolla is small, slender, with four small, spreading lobes.

The fruit is very small, roughly hairy, crowned by the erect calyx teeth.

Flowers may be found between April and October, but I have seen the plant in flower in March and also in December.

The flowers contain honey at the base of the pistil, and it is concealed at the base of the tube. Female and complete flowers occur on different plants. As a rule they are liable to be self-pollinated owing to the inconspicuous flowers, in the absence of insect visitors. In the complete flowers the anthers ripen first. They are larger than the female flowers. They are, however, sometimes homogamous. Small butterflies are able to reach the honey best owing to the narrowness of the tube, which favours also self-pollination when insects do not cross-pollinate the flower. Flies are the chief visitors.

To some extent, the fruit may be dispersed by animals, but the hairs are not very long. The persistent calyx may assist in the dispersal of the fruit by the wind.

Field Madder is called Allison, Dodger, Herb Sherard, Madderlen, Spurwort.

SHERARDIA ARVENSIS.—*The illustration* (*Fig.* 62) *shows the habit of the plant and the whorls of leaves.*

39. The Valerian Group.

In the order Valerianaceæ in the British Isles there are three types—the Valerians, the Spur Valerian, and the Lamb's Lettuce type. One of each of these is described. In the first the corolla-tube is equal or swollen, and there are three stamens; in the second the corolla-tube is spurred and there is one stamen; in the third the calyx is tubular or lobed (in the two former it is pappose), and the corolla-tube is inversely conical.

There are over two hundred species of this group, included in eight genera. They are natives in Europe, Asia, Africa, and America, but chiefly natives of the North Temperate Zone. The group shows affinity with the Teasel group and the Dandelion group.

The plants of this order are herbaceous and rarely shrubs. The leaves are opposite, without stipules.

The flowers are small, generally irregular, asymmetrical, hermaphrodite, or unisexual, usually in cymose panicles, which are dichotomous, repeatedly branching into two forks.

The calyx is superior, the limb membranous, or pappose, developing a pappus in the fruiting stage, involute in bud. The corolla is gamopetalous, tubular, funnel-shaped, the base equal, swollen, or spurred, with five unequal teeth, blunt, overlapping in bud. The disc is small. The stamens are epipetalous, inserted at the base of the tube of the corolla,

The Author. FIG. 62.—FIELD MADDER (*Sheradia arvensis*). *See page* 288.

FIG. 63.—VALERIAN (*Valeriana dioica*).

Messrs. Flatters and Garnett. *See page* 291.

one to five, alternate with the petals. The filaments are slender. The anthers project, open inwards, and are versatile. The pistil is syncarpous, with three carpels. The style is slender, the one to three stigmas blunt or two- to three-lobed. The ovary is one- to three-celled.

The fruit is small, an achene, dry and indehiscent, crowned with the calyx and pappus in two cases. Two of the cells are empty.

The group includes plants that have aromatic, anti-spasmodic, and stimulant properties.

The Spikenard is included in this group, and is the Nardus of the older authors. Some of these plants are employed as salads, as Lamb's Lettuce, Spur Valerian. The latter has an intoxicating effect on cats, and the seeds were used in embalming.

Marsh Valerian (*Valeriana dioica*).

This is an example of a plant in which the male flowers are borne on a different plant to that which bears the female flowers, or diœcious (hence *dioica*). In the first Latin and second English names reference is made to the medicinal properties, both being derived from *valere*. The English prefix indicates the preference of the plant for a marshy habitat. It is of practical use when the names, scientific and vernacular, of a plant thus convey compendial information, and all nomenclature should, where possible, aim at the invention of such mnemonics or aids to

the memory, for the study of things to-day is so much more detailed than in the past that some such *aide-memoire* becomes virtually a necessity.

Marsh Valerian may be found in most of our English counties and in South Scotland, but it is rare further north. It is not found in Ireland. In Northumberland it is to be found at the high altitude of 2000 ft. But this is a frequent characteristic of moisture-loving plants.

Bogs, marshes, wet meadows, are the habitats of this plant, which is a hygrophile or plant which is adapted to moist conditions. In general, such plants have broad leaves, and are fleshy or luxuriant, with large and tall stems and abundant foliage. The plant is also found in damp situations as part of the ground flora of oakwoods where the sessile oak is predominant on siliceous soils.

With it grow Marsh Marigold, Red Campion, Woodsorrel, Bush Vetch, Water Avens, Meadow-sweet, Golden Saxifrage, Sanicle, Angelica, Butter-bur, Wood Loosestrife, Knotted Figwort, Bugle, Rushes, Sedges, etc. In moist ashwoods it is also found on limestone soils, and in limestone swamps. It is found also in the fen formation.

The Marsh Valerian is erect in habit. The root-stock sends forth creeping or running stolons and erect flowering stems.

The stems are ascending, and simple. The radical leaves are long-stalked, ovate, or spoon-shaped, entire; the stem-leaves are divided nearly to the base,

with a larger terminal lobe, the lateral entire, and with narrow segments.

The flowers are in terminal corymb-like cymes, and vary in form and size. The flowers are pink, the female are darker and denser. The bracts are linear. The tube of the corolla is short. The stamens project in the barren flowers. In the small complete flowers the stamens are included, and the flowers form a close corymb. The fruit is smooth, and small.

May and June are the months when this plant is in flower. The plant is a herbaceous perennial. It varies between 2 and 4 ft. in height.

The flowers are unisexual, the plant being usually diœcious and tetramorphic, and the following types have been met with: male flowers with a large corolla and no pistil, male flowers with a smaller corolla and a rudimentary pistil, female flowers with a still smaller corolla and rudimentary anthers, female flowers with a very small corolla, and no anthers. The male flowers being larger than the female, insects would naturally first visit them. As the plant is diœcious, pollination must be effected by insects (or by the wind, which is not the rule). The anthers ripen first, or the stigmas. In rare cases the flowers are complete or hermaphrodite. Honey is secreted in the spur of the corolla. The male florets have a tube 2½ to 3 mm. long, wider above, whereas it is only 1 mm. long in the female florets. Short-lipped insects can reach the honey in either case.

The insect visitors include bees, flies, daddy-long-legs, butterflies, and beetles.

The fruit is spuriously two- to three-celled, and one-seeded. This adds to the lightness of the fruit, which may thus be dispersed by the wind. A pappus is formed on the fruit by the calyx, which also serves the same purpose.

Valerian is called Drunken Sailor and Bovisand Sailors at Plymouth. In Devon the larger Valerian is called Bouncing Bess, and the smaller Delicate Bess. It was also called Blessed Herb because of its reputed power in revealing witches.

The Greeks utilised a kind of Valerian called Phu, to hang up in doors and windows as a charm.

Scott says: "To be delivered from witches, they hang in their entries an herb, called *Pentaphyllon*, Cinquefoil, also an olive branch; also Frankincense, Myrrh, Valerian, Cerven, Palm, Antrichmon, etc.; also Hay-thorn, otherwise Whitethorn, gathered on May-day."

VALERIANA DIOICA.—*In the illustration (Fig. 63), the stoloniferous character can be made out, also the four-angled stem, the ovate, radical leaves, the divided stem-leaves with a larger terminal lobe. The flowers on the right are male flowers, showing anthers.*

RED VALERIAN (*Centranthus ruber*).

An important distinction between this plant and the last plant and Valerianella is indicated by the first scientific name from *centron* and *anthos*

in allusion to the spurred corolla. Another distinction lies in the usually red (sometimes white when cultivated) colour of the flower (hence *ruber*).

In the south of England the Red Valerian appears to be a naturalised plant, and, especially where it grows in chalk-pits, has almost the appearance of being a native plant. It has also been found in Ireland. It appears to be rare in the North.

Native on rocky places in the Mediterranean region, the habitat in this country is disused chalk-pits, chalk cliffs, and old walls, and on railway banks in Kent. In Central England it is confined to the last.

The habit is erect. The rootstock is branched, forming at length a bushy tuft. The whole plant is smooth, and generally bluish-green, as is the case amongst maritime plants, often due to a covering of wax to prevent the clogging of the stomata or pores by which the plant transpires or gives off water in the form of vapour. The waxy coat also prevents adverse effects of strong light or intense heat. The stems are stout, woody below, with erect, hollow branches, round in section. The lower leaves are lance-shaped, stalked, the upper stalkless, entire, or with a few teeth below, triangular to ovate.

The flowers are numerous, in long cymes, dense, arranged all on one side, forming a terminal panicle, red or white. The spur of the corolla is shorter than the tube. The calyx in fruit unrolls at the border into a bell-shaped feathery pappus. The fruit is ovoid, rough, narrow, flattened. There is a single stamen.

Between June and September one may look for the flowers in bloom. The plant is a herbaceous perennial and is from 1 to 2 ft. high.

Honey is secreted at the base of the spur. The tube is divided into two parts by a membranous partition. In the smaller is the pistil. The larger half is produced into a spur, and lined with hairs which point downwards and protect the honey. The honey can only be reached by long-lipped Lepidoptera. The stamen is united to the corolla and free just below the lobe. It projects when the flower opens, and when ripe the stigma lengthens, and in this way self-pollination is not possible. The long stamen may curl over, however, and touch the stigma of an adjacent floret.

The fruit is crowned with a feathery pappus, which causes it to be dispersed by the wind.

The Red Valerian is much cultivated in gardens and is a handsome plant.

The plant is also called American Lilac, Red Cow Basil, Bouncing Bess, Bovisand Soldier, Cat-bed, Cow-fat, Delicate Bess, Drunken Sailor, Drunken Willies, Fox's Brush, German Lilac, Good Neighbourhood, Kiss-me, Pretty Betsy, Pretty Betty, Scarlet Lightning, Sweet Betsy, Sweet Mary, Red Valerian.

CENTRANTHUS RUBER.—*The form of the flower is shown in Fig 64, arranged in a secund manner in a dense cyme.*

The Author. FIG. 64.—SPUR VALERIAN (*Centranthus ruber*). *See page* 294.

The Author. FIG. 65.—LAMB'S LETTUCE (*Valerianella Olitoria*). *See page* 297.

LAMB'S LETTUCE (*Valerianella olitoria*).

Known also by the name of Corn Salad, which indicates the habitat of this plant, it is allied to the Valerians, but the fruit is not crowned with a feathery pappus, and instead of being perennial, the plant and its allies are annual.

Corn Salad is found as a doubtful native in all parts of the British Isles, as far north as the Shetlands, and in the Channel Islands.

The habitat is hedgebanks and cornfields, waste places, railway banks, etc. Doubtless it owes its distribution largely to having been formerly used as a salad (hence Corn salad).

The habit is erect or ascending. The plant is rather limp, brittle, and smooth, or rarely downy. And the stems are erect, or ascending, branched from the base, much forked. The radical leaves form a rosette, and are rounded, round at the tip, linear to oblong, or oblong to lance-shaped or spoon-shaped, entire or sparsely toothed, narrowed below. The stem-leaves are moreover broad-based, clasping the stem, toothed.

The flowers are small, pale lilac, and form a capitate, dense, terminal cyme, with opposite, lance-shaped or linear, toothed bracts.

There is no calyx-limb. The fruit is small, smooth or hairy, three-celled, the fertile cell with a spongy mass of tissue or corky on the back, the two

empty cells contiguous. It is as broad as long, flattened at the sides with a slight furrow; the seed is seen in section in the centre, with a corky mass one side, the empty cells the other, separated by a groove.

The plant is in flower between April and June and is a herbaceous annual. Sometimes it is a foot in height.

The honey is concealed and lies in the tube, there being no spur. The flowers are dichogamous, anthers and stigma not ripening simultaneously, and they are adapted to cross-pollination by insects. Muller found it was visited by four beetles, eighteen flies, one Hemipterous insect, eleven bees, two Lepidoptera.

Owing to the spurious character of the two cells of the fruit and the corky mass on the other side of the single seed in the fruit, the latter is adapted to wind-dispersal, these contrivances reducing its specific gravity.

Cornel-sallet, Corn-salad, Lamb's Lettuce, Milk Grass, Potherb, are all the names by which it is known.

VALERIANELLA OLITORIA.—*In Fig.* 65 *the opposite, broad-based leaves, with the dichotomous flower-stalk and terminal cymes (with small fruits), are illustrated.*

40. The Teasel Group (Summary).

(*Introductory Volume, p. 126.*)

In this group, or the order Dipsaceæ, are included the Teasels, and the Scabiouses. The former have the floral bracts spinous, projecting, and covering the head, and as an example the Common Teasel was described in the Introductory Volume. In the Scabiouses the bracts do not project, and are scale-like or are absent. As an example of these last the Field Scabious is described in this volume.

There are about one hundred and fifty species included in less than a dozen genera, which are found chiefly in the Old World in the N. Temperate Zone.

The Teasel and Scabious groups are perennial or biennial herbaceous plants.

The leaves are opposite, rarely in whorls, and without stipules. In the Teasels they are united below, forming the "pitcher."

The flowers are in heads or cymes. The outer florets are drawn out on one side, as in the Dandelion group, etc.

In a few cases bracteoles occur. There is an epicalyx very frequently at the base of the ovary, of two bracteoles united. The outer bracts form an involucre. There are no inner bracts, or they are found below the florets. The floral bracts form an involucel below the calyx-tube. The calyx and corolla have the parts in fives, or fours by the union of

two. The calyx is gamosepalous, superior, pappus-like, with a membranous involucel, and is attached to the ovary, cup-shaped, entire, lobed, or fringed with hairs, with rigid bracts. The corolla is gamopetalous, tubular, funnel-shaped, or cylindric, often curved, epigynous, with four to five lobes, unequal, blunt, overlapping in bud, the larger or anterior lobes overlapping. The stamens are epipetalous, four or five inserted on the corolla-tube. The filaments are slender, sometimes unequal, bent inwards in bud, the anthers projecting, not united and versatile. The pistil is syncarpous. The ovary is one-celled. The style is slender, the stigma simple. The fruit is a dry, one-seeded achene, crowned by the pappus-like calyx. The seeds possess endosperm.

The anthers usually open first.

The fruit enclosed in the epicalyx is dispersed by the wind.

The group includes the Fuller's Teasel and some ornamental garden plants.

FIELD SCABIOUS (*Scabiosa arvensis*).

One of our loveliest wild flowers, Field Scabious is generally distributed in Great Britain up to the Northern Isles, and is found in Ireland and the Channel Islands.

As the first vernacular and second Latin name imply it is found in fields. The second English and first Latin name refer to a supposed remedy the

Scabious affords for scabies, a skin disease. It is to be found in pastures, on dry banks, open woods, cultivated places, cornfields, where the lovely masses of blue flowers form a striking contrast to the golden corn. It is found on clay or loam in neutral grassland with pasture grasses, St. John's Wort, Tormentil, Meadow Crane's Bill, Burnet Saxifrage, Sulphurwort, Wild Carrot, Oxeye Daisy, Long-rooted Cat's Ear, Harebell, Germander Speedwell, Selfheal, Ribwort Plantain, etc. It also occurs on chalk grassland.

The habit is erect. The plant is tall, much branched above, with a stout rootstock, very hairy or bristly, especially below. The radical leaves are numerous, oblong to lance-shaped, stalked, simple, entire, toothed or scalloped, the stem-leaves deeply divided or lobed, toothed, broad below, stalkless. All may be pinnatifid in some cases.

The convex capitula or flowerheads are pale lilac or blue, flattened, borne on long, stout stalks, with broad, leafy, involucral bracts in two series, the involucre being blunt, short. The involucels are very small and hairy.

The outer florets are larger, more oblique than those in the centre, and four-lobed. The calyx has eight awned teeth. The receptacle bears hairs between the florets. The corolla is hairy, the inner ones being redder, the outer larger, unequal and radiating. The anthers are yellow.

The limb of the calyx falls at length. The fruit is

ovoid, beaked, angular, crowned by eight to ten radiating teeth or short bristles.

Flowers are to be found between June and August or up till September and even October. It is a herbaceous perennial, like most meadow plants, and from 1 to 4 ft. in height. The flowers contain abundant honey on the upper surface of the ovary, and it is easily accessible. The stamens yield much pollen so that insect visitors of all types are numerous. Hairs above protect the honey from rain.

The stamens project when the flowers open, 4 to 5 mm., and the anthers open successively, the male condition lasting some days. After they have shed pollen they shrivel up. The pistil elongates and takes the place of the stamens.

The outer florets open first, then the central ones. Some florets are female, early in the season, with imperfect anthers, and are less numerous in some places. The florets in the centre have shed pollen before the stigmas in the marginal florets are ripe. The stigmas ripen together. The head is thus male first, then female. This prevents self-pollination. As many as 100 visitors have been counted.

The fruit is crowned with bristles and may be wind-dispersed.

This lovely wild flower has had numerous names bestowed upon it, such as Bachelor's Buttons, Billy Button, Black Soap, Blue Buttons, Bluecaps, Bluemen, Broadweed, Cardies, Clodweed, Clogweed, Curl-doddy, Egyptian Rose, Gipsy Flower, Gipsy

J. H. Crabtree. FIG. 66.—FIELD SCABIOUS (*Scabios arvensis*). *See page* 300.

H. A. Cox. FIG. 67.—HEMP AGRIMONY (*Eupatorium cannabinum*). *See page* 306.

Rose, Lady's Cushion, Pincushion, Scabious, Scabridge, Scabril.

SCABIOSA ARVENSIS.—*In Fig.* 66 *the divided upper stem-leaves are shown, with the appressed hairs on the stem and the spreading hairs on the flower-stalks. The outer florets are seen to develop first, the central ones, not so large, being undeveloped. The expanded florets are male, with anthers only.*

41. THE DANDELION GROUP (SUMMARY).

(*Introductory Volume, p. 129.*)

The order Compositæ is one of the largest in the whole plant world. There are eleven thousand species and over eight hundred genera. Not only are there a vast number of species, but the group is a dominant one, these plants, like the grass type and the tree type, in some cases giving quite a character to the vegetation. Thus, in an ordinary meadow, the Daisy may constitute nearly the most abundant species when in flower, making the whole field white with bloom. The Hawkweeds in mountainous districts are similarly abundant to the exclusion of other types. This is partly due to their habit, the rosette habit, which is, of all growth forms, the most adapted to aggressive colonisation or invasion. Furthermore, the floral mechanism is highly specialised and the contrivances for pollination and fruit dispersal are the most suitable, and give the order a pull, as it were, over other types.

The Compositæ are found in all parts of the world. The nearest allied orders are the Teasel group, Valerian group, and Lobeliaceæ.

Most of the Compositæ are adapted to dry conditions. Few, save *Aster*, *Bidens*, etc., are marsh or aquatic plants, and very few are climbing plants. None are epiphytes.

Most of the plants are herbaceous and the order includes very few shrubs or trees. The latter are more or less characteristic of oceanic islands.

The leaves are usually alternate, rarely opposite, as in *Bidens*, etc., or in whorls, and radical in the latter case. There are no stipules as a rule. The root is frequently a tap root as in the Dandelion, but it is tuberous in the Dahlia. There are oil-glands in most types. In the Liguliforæ (see below), as in the Dandelion, latex is present.

The inflorescence is racemose, the flowers forming spikes, or, more usually, heads or capitula. Thus, the "flower" of the Daisy consists of not one flower, but a large number of sessile florets borne on a receptacle. The heads may form racemes, corymbs, or compound heads. Around or below each head is a whorl of bracts, or an involucre answering the purpose of a common calyx (which is usually replaced by pappus or bristles). This protects the flowers in bud and the fruit before dispersal.

The receptacle is generally flat, convex, or spindle-shaped, and is smooth, or hairy, and there are scaly

bracts between the florets in some, or not, these being sometimes bristle-like.

Usually the flowers are hermaphrodite and homogamous, but vary in this respect. They may be all tubular and actinomorphic in the disc, or ligulate, and zygomorphic. Or they may be tubular in the disc, ligulate in the ray. In the Knapweed the outer florets may be actinomorphic and the central of a different size. The outer florets may be bisexual, or the inner bisexual or male, the outer female or neuter.

The usual combination is the last, *i. e.* gynomonœcious, the disc florets bisexual, the ray female. This arrangement is an economic one, the ray florets serving to attract, the disc florets being adapted for fruit-formation.

The insertion of the flower is epigynous, the parts of the flower being usually in fives. There is no calyx, or its equivalent, in some types. In others it is a mere rim on the ovary, but as a rule it is represented by the pappus which crowns the fruit.

The flowers are tubular and actinomorphic, or ligulate and strap-shaped, or labiate. In the ligulate florets the five teeth represent the petals, but there may be only three. The corolla is gamopetalous, and epigynous. The disc is epigynous. There are five stamens, which are epipetalous, inserted on the corolla-tube, with short anther-stalks. The anthers are united or syngenesious (the group represents Linnæus's Syngenesia) and form an anther-cylinder.

They open inwards. The ovary is one-celled and inferior. The style is branched or divided into two forks, with linear arms, *i.e.* with an anterior and a posterior lobe or stigma. The tips are papillose cones, the margins stigmatic. The pollen is rounded and rough. The ovule is solitary and erect. The fruit is dry, indehiscent, an achene, or really a pseudo-nut, there being more than one carpel. It is crowned by the pappus.

Honey is secreted at the base of the style in honey-glands, the tube concealing and protecting it. Pollen is pressed up to the tube upon the surface of the flower-head, swept up the tube by the pollen-brush on the style, upon which it falls. After this the style lengthens and the stigma lies above the pollen. The lobes curl back, and if insects do not visit the flower self-pollination results, if the lobes come in contact with the pollen. Rarely the flowers are wind-pollinated.

As a rule the fruits are wind-dispersed, the pappus forming a parachute apparatus.

The group includes many useful plants, as the Artichoke, Chicory, Endive, etc.

Hemp Agrimony (*Eupatorium cannabinum*).

Hemp Agrimony is general throughout Great Britain, but less common in Scotland. It is a native of Ireland and the Channel Islands. The name refers to the resemblance of the leaves to those of the Hemp.

River banks, moist places, banks, bushy places, banks of streams, moist woods are the habitats of this plant. It also grows in limestone swamps, with Meadow Rue, Globe Flower, Meadow Sweet, Water Avens, Grass of Parnassus, Valerian, Butter Bur, Marsh Thistle, Marsh Lousewort, Marsh Orchis, Marsh Helleborine, etc.

The habit is erect. The plant is downy, woody below. The stem is nearly simple, round in section, with short branches furrowed, rough. The leaves are opposite, divided into three to five leaflets. The leaflets are broadly lance-shaped, coarsely toothed, the middle lobes longest; the radical leaves are stalked and inversely lance-shaped, the stem-leaves nearly stalkless.

The flower-heads form a terminal clustered corymb, with five to six heads, with about five florets in each. The florets are pale purple or white. The involucres are longer than the florets, cylindrical, with few, unequal bracts, which have a membranous margin, and are linear to oblong, blunt, the outer shorter.

The pappus is white and hairy or rough, the hairs in one row. The fruit is angular. The corollas are covered with resinous points.

The flowers are in bloom detween July and September. The plant is a herbaceous perennial, 2 to 4 ft. in height.

In the Hemp Agrimony the florets are all tubular and bisexual. The flower-heads are numerous, and they make the plant conspicuous. The floret is

4½ mm. long, the tube 2½ mm., the upper part or throat, 2 mm., and bell-like. The anther-tube does not project beyond the bell. The anthers open inwards, and pollen falls on the upper part of the tube. The upper branches of the white style are projecting when the flower opens, and are covered with hairs, sweeping the pollen up on the latter. The stigmatic part itself is included in the corolla below the hairy part. When the stigma is ripe the papillose portion lengthens and becomes receptive. Neighbouring florets are pollinated with pollen from the sweeping hairs, as the florets are close together.

The insect visitors include a large number of Butterflies, the Peacock Butterfly, Hemiptera, Bees, Flies.

The "achenes" are provided with a pappus and wind-dispersed.

The plant was used formerly as a tonic.

Bastard Agrimony, Dutch Agrimony, Hemp Agrimony, Water Agrimony, Andurion, Filæra, Bastard Hemp, Water Hemp, Hempweed, Raspberries and Cream are some of the vernacular names.

Hemp Agrimony was one of the plants dedicated, according to Bauhin, to the Virgin Mary, and it was also known as St. John's Herb.

EUPATORIUM CANNABINUM.—*In Fig. 67 the habit is well shown, also the leaf characters and the crowded flower-head, in terminal corymbs.*

Marsh Cudweed (*Gnaphalium uliginosum*).

One of the characteristics of this plant is indicated in the first scientific name, which is derived from the Greek *gnaphalion*, referring to the woolly habit.

In the second Latin name and the English prefix we have a reference to the habitat of the plant—marshy places.

Marsh Cudweed is general in Great Britain as far north as the Shetlands, and in Ireland is found at an altitude of 2000 ft. It occurs also in the Channel Islands.

The habitat is damp places, on light soils, fields and waste places, wet sandy places. It is found in low-lying clayey soils, on clays and loams where there is a wet meadow association of the Common Rush, with Lesser Spearwort, Celery-leaved Crowfoot, Marsh Marigold, Cuckoo-flower, Ragged Robin, Bog Stitchwort, Great Bird's Foot Trefoil, Meadow Sweet, Willow-herbs, Pennywort, Marsh Bedstraw, Nodding Bur Marigold, Butterbur, Creeping Jenny, Water Betony, Bog Speedwell, Horse Mint, Water Pepper, etc.

The habit is tufted. The plant is densely cottony, much branched. The stems are numerous, erect or prostrate below, cottony above, rarely smooth. The leaves are narrow, linear, swollen upwards, acute or blunt, and the leafstalk is not clasping. The upper leaves are wavy at the margin.

The flower-heads are many, in terminal, dense clusters, stalkless, opposite a tuft of long, linear leaves. The phyllaries are brown, narrow, more or less acute, with a membranous border.

The florets equal the involucre in length, the three to four outer rows are slender, with some tubular ones in the middle. The fruit is very small, smooth or hairy, hardly flattened, with a pappus of distinct hairs, falling at length.

The flowers are in bloom between July and October. The plant is a herbaceous annual, from 6 to 9 in. high. The flower-heads are small. The ray florets are female, threadlike, in several rows. The disk florets are bisexual and tubular. They are pollinated by the wind.

The achenes are provided with a pappus, and wind-dispersed. The only vernacular names are Cudweed and Wartwort.

GNAPHALIUM ULIGINOSUM.—*In Fig.* 68 *the narrow leaves, the much-divided stem, the cottony down on the whole plant, and the flower-heads, in terminal close clusters, are well shown.*

NODDING BUR MARIGOLD (*Bidens cernua*).

Of the two Bur Marigolds this one is by far the rarer. The first Latin name (*bidens*, two teeth) is applied owing to the two stiff pappus-bristles in some cases. The name *cernua*, nodding, alludes to the drooping or nodding flower-heads. The name "bur" refers to the burred or barbed fruits. Marigold is

W. E. Mayes. FIG. 68.—MARSH CUDWEED (*Gnaphalium uliginosum*). *See page* 309.

W. E. Mayes. FIG. 69.—NODDING BUR MARIGOLD (*Bidens cernua*). *See page* 310.

1. Root, rootlets and stem base. 2. Dwarf plant (two to three inches).
3. Floret with anthers exserted forming a tube.

applied owing to the general resemblance of the flower to that of the Marigold (*Calendula officinalis*)—a favourite garden flower.

The Nodding Bur Marigold is found throughout the British Isles, but is very local or rare compared with the Three-lobed Butterbur, in which the flower-head is erect, and the leaf is divided into three segments, whereas here they are entire. The Three-lobed Butterbur has, however, a variety with entire leaves, a characteristic of the Nodding Bur Marigold, but the number of bristles in the pappus, two in the former, three to four in the latter, is a distinctive character.

The habit is wet ditches, marshes, watery places. It was noted as occurring with the Marsh Cudweed in the wet meadow Rush association characteristic of clayey soils.

The habit is erect. The plant is stout, leafy, smooth or slightly hairy above, with spreading branches above, succulent, round in section, opposite. The leaves are stalkless, entire, narrowed below, in pairs, united below, oblong to lance-shaped, coarsely toothed.

The flower-heads are solitary, drooping on terminal flower-stalks, without bracts, brownish-yellow; the outer phyllaries are leafy, spreading or turned back, the inner shorter, shining, broadly oblong, blunt, with black streaks, yellow edges, and large. The ray florets are short, few, broad, or absent. All are usually tubular.

The achenes have two to four bristles, the fruit being narrow to inversely ovoid, the ribs and bristles barbed and wedge-shaped.

The flowers bloom from July to October. The plant is a herbaceous annual, and may reach a height of 2 ft.

The ray florets may be absent, and if present they have either stamens or pistil, not both. The tubular florets are bisexual. The anther-cells are simple. The style arms are tipped with papillose cones. The flowers contain honey and are insect-pollinated.

The barbed fruits are liable to catch in the wool of animals which are in the habit of coming down to the waterside to drink.

This plant is also called Water Agrimony, Baclin, Double tooth.

The second name is used in Hampshire according to Pulteney, an old Leicestershire botanist.

BIDENS CERNUA.—*In Fig.* 69 *the whole plant is shown with nodding flower-heads and opposite entire leaves with serrated margin. The details show the root, rootlets, and stem base, a dwarf plant (two to three inches high) in flower, and a floret with anthers exserted forming a tube.*

42. THE HAREBELL GROUP (SUMMARY).

(*Introductory Volume, p. 148.*)

In the Harebell Group, or the order Campanulaceæ, embracing also the order Lobeliaceæ, are included

Water Lobelia, Sheep's Bit Scabious, Ivy-leaved Bellflower, the Spiked Rampions, Bellflowers (of which one, the Nettled-leaved Bellflower, was described in the Introductory Volume), and Venus' Looking-glass.

There are about a thousand species and nearly sixty genera in this order, which are found chiefly in the N. Temperate Zone, but some are subtropical.

Most of the Bellflower group are herbaceous perennials. They have a milky juice or latex, bitter and acrid.

A few only are shrubs or more rarely trees. The leaves are alternate, without stipules.

The inflorescence may be terminal or not. It is usually racemose, with a terminal flower in the Bellflower type. There may be a single or more than one flower in the axils of the bracts. The flowers are usually complete, regular or zygomorphic, and epigynous, with the parts of the flower usually in fives. In the Bellflower type the odd sepal is posterior, anterior in the others.

By a twisting of the axis through a semicircle before the flower opens, the odd sepal is at length posterior. The calyx is gamosepalous, wholly superior, or half-superior, five-cleft and open, persistent. The corolla is gamopetalous, regular, except in *Lobelia*, epigynous, with five lobes, usually persistent, the limb regular, oblique or two-lipped, valvate or induplicate in the bud. There are five stamens, which are epipetalous, or epigynous, and

alternate with the lobes of the corolla. The anthers are sometimes united around the style, opening inwards, and are equal or unequal, and tipped with hairs or not. The pistil is syncarpous. The style is simple, tipped with a ring of hairs or clothed with deciduous hairs. There are two to eight stigmas, or as many as the carpels, hairy on the back. The ovary is two- (or more) celled. The fruit is a capsule, opening by different methods, or a berry. The seeds are minute.

The flowers contain honey, and the anthers are ripe before the stigmas. The style has the pollen shed on it by the anthers, and has a bunch of hairs which collect it and present it. Afterwards the stigma ripens, and may curl back and touch the pollen.

The seeds are wind-dispersed.

43. The Heath Group (Summary).

(Introductory Volume, p. 151.)

According to some authorities the Whortleberries are placed in a separate order—Vacciniaceæ—to the Heath group or order Ericaceæ. As a type of the latter or suborder Ericeæ the Cross-leaved Heath was described in the Introductory Volume. In this volume a type of the suborder Vaccinieæ or *Vaccinium Vitis-Idæa* is described.

The order is a fairly large one, there being thirteen hundred and fifty species and about fifty genera. They are found principally in temperate and cold

regions. The Heath group is confined to Africa, the Mediterranean region, and Europe. The Heaths are social types, which have a typical growth-form, and give their character to the physiognomy of a district. Thus a heath may consist of Heaths entirely, and the habit of the individuals is essentially alike. As they grow in peaty soil, which is rich in humous acid, they are adapted to physiological drought, already explained.

They are woody undershrubs, shrubs or trees, as in the Strawberry Tree.

In the Rhododendron group there are winter buds even when the plants are evergreen. Scale leaves cover the buds, which are deciduous. Terminal rosettes of leaves are typical. The leaves are elliptic, leathery, hairy, with a thick cuticle and water storage tissue. In the Heaths there are no winter buds, and they are evergreen; the leaves are in whorls, and hair-like, with the margin inrolled as in the Crowberry.

The flowers are often solitary or in racemes, with a bract and two bracteoles. They are hermaphrodite, regular or slightly zygomorphic. The calyx is superior or inferior, with four to five teeth or lobes. The corolla is usually bell-shaped, hypogynous or epigynous, with four to five teeth or lobes, rarely consisting of five petals. The stamens are eight to ten, hypogynous or epigynous, in two whorls, the outer opposite the petals, or slightly epipetalous. The anthers open inwards and are one- to two-celled,

the cells blunt or with tubular tips, awns, or appendages, opening by pores at the top. The pollen-grains are in tetrads. The disk is annular and lobed, or made up of glands or scales.

The ovary is four- to five-celled, many-seeded, superior or inferior. The style is terminal, the stigma small and simple. The fruit is a capsule, drupe or berry. The seeds are small. The flowers are adapted to bees, being pendulous. They exhibit a "loose pollen" mechanism, showers of pollen being set free when the anthers are touched.

COWBERRY (*Vaccinium Vitis-Idæa*).

The first scientific name was applied by Pliny the Elder (A.D. 23 to 78). He perished in the eruption of Vesuvius which buried Herculaneum and Pompeii. On the day of the catastrophe he was at Misenum, in command of the fleet, and seeing the outburst he sailed for the site of the eruption. He was curious to ascertain the character of the volcanic phenomena and made observations. He was suffocated by the fumes next day whilst attempting to escape. His classic history of the world was first translated in 1468 and into English in Elizabeth's reign. He gave many of the generic names, as in this instance, which later writers adopted, and Linnæus used them in his *Species* and *Genera Plantarum*, modern scientific nomenclature dating from the publication of these works, the former in 1753.

Probably Pliny intended *Vaccinium* for *baccinium* to

denote the berry. The name Cowberry may be due to an assumption that the generic name was derived from *vacca*, a cow. The second name means Vine of Mount Ida.

Cowberry or Red Whortleberry is found in all parts of the British Isles from Devon, South Wales, and Warwick to the Shetlands. It is unknown in South-East England. In the Highlands it ascends to over 3300 ft. in the Arctic Alpine zone.

A plant of mountainous districts found in open woods and mountain heaths, dry rocky moors, Red Whortleberry is an upland plant.

It is found on the upland heaths of North East Yorkshire, on steep slopes on *Calluna* heath, as in Perthshire, in Scottish pinewoods on sandy soil.

On siliceous soils it is found in dry oakwoods with the sessile oak in open situations where the humus is of an acid, not raw character (as in dry woods). It is a member of the Bilberry moor association on the upland moors of the Pennines, and on heather moorland, in closed moorland associations made up of Whortleberry and Ling in the arctic alpine zone, where mountain-top detritus accumulates on elevated moorland.

Red Whortleberry is an undershrub in habit. The stems are smooth, woody, wiry, wavy, prostrate, then ascending, branched, the branches downy, naked below, ascending or trailing.

The leaves are evergreen, inversely ovate, or oblong, in two ranks, glossy, deep green above, pale and

44. The Bird's Nest Group.

This type and the Wintergreens are placed in the order Pyrolaceæ in some arrangements, or with the last group, or in a separate order as here, the order Monotropacæe.

The single British species described here is a saprophyte, erect, succulent and herbaceous.

The leaflets are simple, erect, brown or red. The stem is scaly, the scales passing into bracts above.

The flowers are solitary, in a spike or raceme. There are two to six sepals or bracts, and they are deciduous. There are three to six petals, which are occasionally united below, erect or spreading, overlapping in the bud. The stamens are hypogynous, and six to twelve in number. The anther-stalks are distinct or united by their base. The anthers open by transverse valves, or slits. In the Ericaceæ they open by pores. The ovary is four- to six-lobed, one- or four- to six-celled. The style is simple, with a pinheaded, peltate, terminal stigma, which is lobed or funnel-shaped. There are many ovules, which are very small and naked.

The capsule is membranous, four- to five- or six-celled, four- to six-lobed, opening by slits opposite the middle of the cells. The seeds are very small.

The group is closely related to the Heath Group. None of the plants which are natives of the North Temperate zone, Europe, Asia, America, have any properties of importance. From the Wintergreens

the Bird's Nest Group differs in not possessing green leaves.

YELLOW BIRD'S NEST (*Monotropa Hypopitys*).

This plant is one of those that obtain their main nourishment not directly, like green plants, by carbon assimilation, the plant being yellow in this case or white, but indirectly from other plants, living entirely on the products that other plants prepare for them. They are thus called saprophytes. Parasites derive part of their nourishment from other plants, but are sometimes when semi-parasites green and thus work for themselves, and in return for help derived from their hosts, as the plants they sponge upon are called, they give something back. Saprophytes live on decaying matter and absorb the products of fermentation. They take in carbon from the soil in the form of organic compounds. Such plants do not, therefore, require leaves, and in their place they usually possess scales. Some of these plants, as the parasitic Toothwort, have the scales modified to serve as insectivorous contrivances.

When plants live in a state of partnership with others they are symbiotic, living together for mutual benefit, as in the case of Lichens, where the fungus provides a lodging for the imprisoned algal element which provides nutriment in return for its lodging.

The Yellow Bird's Nest possesses short, fleshy, much-branched roots which are covered up by the

humus, and clothed with a thick mycorhiza, as in Pines and some Heaths, a fungus mycelium. The mycelium obtains the nutritive matter from the humus and yields it up to the Yellow Bird's Nest, thus carrying out the work of absorption. The fungus is doubtless benefited in some manner in return.

The Yellow Bird's Nest is found in many parts of England, but only occasionally in Scotland, and is very rare in Ireland, chiefly in the centre of the country.

The habitat is woods, at the roots of fir, beech, and birch. It occurs on the chalk in beechwoods, and on the coast in the sand dune formation in the creeping willow association.

The plant is a saprophyte in habit, smooth or downy. The stem is stout, creamy-white, fleshy, succulent, simple, with ovate scales in place of leaves, the flowers clustered at the extremity in the form of a bird's nest. The scales are not numerous, and are toothed.

The flowers are few, or many, in a short terminal raceme, drooping till in fruit. The sepals and petals are oblong, notched, about equal, and blunt. The ultimate flower-stalks are short, erect in fruit, the bracts scale-like. The anthers are small, borne on slender stalks, which are incurved, the alternate ones longer, and these open by transverse valves. The parts of the terminal flowers are in fours, the lateral ones in fives.

The style is short. In the terminal flowers there are eight stamens, in the lateral ones ten stamens. The fruit is ovoid or round. The plant turns black when dry.

The flowers bloom in July and August. The plant is a perennial saprophyte, growing to a height of a foot.

The anthers and stigma ripen at the same time. In the terminal flowers the honey lies in eight glands, in the lateral ones in ten at the base of the ovary, projecting into hollows in the corolla. The hairs on the styles enable the plant to avoid self-pollination.

The capsule opens by five valves, and the seeds, being minute, may be dispersed by the wind.

The only names by which the Yellow Bird's Nest is known are Bird's-nest, Pine-sap.

MONOTROPA HYPOPITYS.—*In Fig. 71 the flowering stem is shown with scales in place of leaves, white or yellow in colour, with the flower drooping in one case, then erect, forming a terminal raceme.*

45. THE SEA LAVENDER GROUP.

There are two British types of the order Plumbaginaceæ, the Thrifts and the Sea Lavenders. In the former the flowers are in a bracteate head, in the latter they are in panicled one-sided cymes.

There are about two hundred and eighty species included in ten genera, which have a world-wide

range, but they are very largely maritime or coastal, some growing on steppes, others on lofty mountains. They are adapted to dry conditions.

These plants are perennial, herbaceous plants, or occasionally shrubs. The leaves are narrow, alternate, forming a rosette and radical, without stipules, fleshy, with water-glands and chalk-glands.

The inflorescence is racemose or cymose, with bracteoles. The flowers are regular, hermaphrodite, the parts in fives, the odd sepal posterior. The calyx is gamosepalous, inferior, tubular, plaited, five-cleft, persistent, and membranous.

The corolla is sometimes more or less gamopetalous, regular, hypogynous, with five petals, with long claws, which are distinct or united, twisted in bud, or the corolla being monopetalous, overlapping. There are five stamens, which are epipetalous, and opposite the petals. The anther-stalks are slender. The anther-cells burst inwards. The ovary is one-celled, superior. There are five styles, or three to four, distinct or united, the stigmas hair-like or linear. The fruit is one-celled, one-seeded, a nut, enclosed in the calyx-tube, membranous, five-valved, or bursting irregularly. The seed is pendulous.

In this group the handsome Leadwort or Plumbago, often grown in glass-houses in this country, is included. Some of these plants are astringent or acrid. Some—as Thrift—grow equally well inland, and this plant is now a favourite border-plant.

SEA THRIFT (*Statice maritima*).

Once called *Armeria*, the Monkish Latin for *Flos Armeriæ*, this plant was so named from its resemblance to a pink. The second Latin name indicates its maritime habitat.

Along the British coasts, especially where they are rocky, as on the west, this plant is common everywhere. It is also found inland on lofty mountains, a characteristic it shares with some other maritime plants as Scurvy Grass, Sea Campion, Sea Plantain.

Rocky, stony, muddy or sandy sea-shores and alpine rocks on mountains constitute the habitat of Thrift. It occurs in the salt-marsh formation, in the general salt-marsh association, with Sea Spurrey, Sea Aster, Sea Lavender, Sea Plantain, Orache, Samphire, Sea Blite, Sea Arrow Grass, Sea Manna Grass, and in shingle-beach communities.

Sea Thrift has the typical rosette habit. The root-stock is woody, tufted, branched. The plant is smooth or downy. The leaves are narrow to linear or broad, blunt or acute, one-nerved, in dense tufts, with impressed points on both surfaces.

The only aërial stem is a scape, with hairs spreading or turned back, or smooth, simple, leafless, with a terminal head of pink or white flowers. The involucre is torn, the outer bracts not so long as the head, ovate, acute, produced into long, brown or green points. The inner is oblong, blunt, with a

membranous margin. The ultimate flower-stalk is equal in length to the calyx. The calyx is decurrent on the flower-stalk. It has five downy ribs, with bluntly pointed lobes. The petal-like border of the calyx is crowned by five slender, short teeth. The limb of the petal is inversely ovate. The fruit is a utricle longer than the calyx-tube, hairy on and between the ribs.

Flowers may be found in June and July. The plant is a herbaceous perennial, sometimes a foot in height.

Honey is secreted in the base of the flower. The flower has a sweet scent. The tube of the corolla is lined with hairs which protect the honey from rain or creeping insects. The five stigmas stand in the centre when the flowers open and the anthers form a ring around them, just over the honey. Later, their position is changed, the anthers bend inwards, the stigmas outwards. The latter become later spirally twisted and come in contact with the anthers. Hence self-pollination may result.

The calyx becomes membranous and funnel-like in fruit and serves as a parachute to disperse the seeds. The plant is often cultivated for the borders in gardens.

A popular plant, it has many common names, such as Arby, Cliff-rose, Cushion (from its habit), Lady's Cushion, Sea Cushion, Cushion-pink, Marsh or Sea-Daisy, Sea Gilliflower, Sea Grass, Lady's Pincushion, Our Lady's Quishion, Pincushion, Pink, French

Pink, Scaw Fell Pink, Quishion, Rock Rose, Sea Turf, Thrift.

The name is corrupted into Swift in Sussex, and in Somerset it is called Cushions or Cushins or Cooshings. In Devon it is called Pink, Sea Pink, French Pink, Sea-gilliflower.

STATICE MARITIMA.—*In Fig. 72 the tufted rosette habit is shown with the woody root-stock and the terminal head of flowers borne on long scapes.*

UPRIGHT SEA LAVENDER (*Limonium binervosum*).

The name *Limonium* was applied to the Wintergreen, as well as Sea Lavender, and means "pertaining to a meadow" or moist grassy place. The old name *Statice* referred to its astringent properties, the plant having been used to check dysentery.

The colour of the flowers, like those of Lavender (Lavandula) in tint, is the origin of the common English name. There are several kinds of Sea Lavender.

This one is found on all the British Coasts, up to Wigtown on the west, and Lincoln on the east.

The habitat is rocky shores, dry rocky maritime banks, or sandy shores.

The habit is the rosette habit. The rootstock is tufted, branched from near the middle, the branches repeatedly forked, long, roughish. The leaves are inversely ovate to lance-shaped, or spoon-shaped, narrowed to the stalk, which is three-veined, shortly

The Author. FIG. 72.—THRIFT (*Statice maritima*). *See page* 324.

W. E. Mayes. FIG. 73.—SEA LAVENDER (*Limonium binervosum*). *See page* 326.

stalked, when dry with a lateral nerve each side of the midrib (hence *binervosum*), without spreading veins.

The flowers are large, in compact spikes, the branches spreading, ascending, the few lowest sometimes flowerless, the spikelets two- to four-flowered, slender, erect, or ascending, overlapping, two-ranked. The spikes are fewer and more distant than in the common plant, and form a long panicle. The bracts are green, and long. The scapes are slender, wavy, forked. The inner bract is oval, with a broad membranous border, deeply tinged with pink.

There are no intermediate teeth in the calyx-lobes. The fruit is a utricle, crowned with the persistent calyx.

This flower is in bloom in July and August. It is a herbaceous perennial, sometimes a foot in height.

Honey is secreted at the base of the flower. The styles do not bear hairs to prevent the rain from spoiling the honey. The flowers are conspicuous, and have in general a floral mechanism like that of Thrift adapted to cross-pollination, but self-pollination is possible. In some foreign species the flowers are dimorphic, and heterostyly appears to be a device here, as elsewhere, to ensure cross-pollination where dichogamy is incomplete.

The fruit is dispersed as in Sea Thrift by a parachute arrangement.

LIMONIUM BINERVOSUM.—*Note in Fig. 73 the rosette of leaves, and the long panicle of flowers with the spikelets with flowers in a cincinnus.*

stalked, when dry with a lateral nerve each side of the midrib (hence *binervosum*), without spreading veins.

The flowers are large, in compact spikes, the branches spreading, ascending, the few lowest sometimes flowerless, the spikelets two- to four-flowered, slender, erect, or ascending, overlapping, two-ranked. The spikes are fewer and more distant than in the common plant, and form a long panicle. The bracts are green, and long. The scapes are slender, wavy, forked. The inner bract is oval, with a broad membranous border, deeply tinged with pink.

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The fruit is dispersed as in Sea Thrift by a parachute arrangement.

LIMONIUM BINERVOSUM.—*Note in Fig.* 73 *the rosette of leaves, and the long panicle of flowers with the spikelets with flowers in a cincinnus.*

46. The Primrose Group (Summary).

(*Introductory Volume, p. 158.*)

Two members of the order Primulaceæ were described in the Introductory Volume—the Great Yellow Loosestrife and the Primrose. In this volume three others are described—Scarlet Pimpernel, Water Violet, and Brookweed.

Four divisions of this group have been made. In the Primulaceæ the ovary is superior, and the capsule valvular. The hilum is ventral. This includes the Primroses, Sowbread, Loosestrifes, Chickweed Wintergreen, Sea Milkwort. In the Anagallideæ the ovary is superior, the capsule opens transversely, and the hilum is ventral, and this includes the Bastard Pimpernel and Scarlet Pimpernel. In the Hottonieæ the ovary is superior, with anatropous ovules. The capsule is valvular. The hilum is basal. The Water Violet is the only type. In the Samoleæ the ovary is inferior, the ovules are anatropous. The capsule is valvular, and the hilum is basal, as in Brookweed, also the only British type.

There are three hundred and fifty species, and nearly thirty genera in this group. They have a wide range, but are chiefly characteristic of the Northern Temperate zone.

The Primrose group consists chiefly of perennials or occasionally annuals. The plants are herbaceous. They have rhizomes or tubers. Many have the rosette habit, as in the Primrose and Cowslip. The leaves

are radical or stem-leaves, opposite or alternate, and do not possess stipules.

The flowers are borne on scapes, terminal when the flowers are not solitary. They are usually regular and hermaphrodite. Many are heterostylic, as in the Primrose and Cowslip. The parts are in fives and the flowers do not possess bracteoles. The fifth or odd sepal is posterior. The calyx is inferior except in Brookweed, gamosepalous, persistent, five- or four- to nine-cleft.

The corolla is hypogynous, gamopetalous, wheel-shaped, bell-shaped, regular, with five combined petals, or five distinct, or none, as in the Sea Milkwort. There are five epipetalous stamens, inserted on the corolla-tube, opposite the lobes, with alternate staminodes, and in the Sea Milkwort hypogynous. The anther-stalks are very short. The anthers open inwards. The ovary is superior, half inferior in Brookweed, syncarpous, of five carpels. The style and stigma are simple. The capsule is five-valved, or opens transversely. The seeds are sunk in the placenta.

The pollination and seed-dispersal are described under the species.

SCARLET PIMPERNEL (*Anagallis arvensis*).

Named also the Poor Man's Weather-glass, because the flowers close in dull or wet weather, the Scarlet Pimpernel is one of the "mercurial" plants, so-

called by Linnæus because they respond to changes in the atmosphere or light intensity. It opens, in fact, at nine a.m. and closes at three p.m. as a rule. The only insect that visits it also is of the "go-to-bed-at-noon" type. The name Pimpernel is from the Latin *bipennella,* referring to the pinnate leaves in some plants.

So common a plant as this is to be found in all parts of the country, but it is rather less common in mountainous districts, as in West Scotland, Wales, the Lake District, and it rarely ascends above the zone of cultivation (1000 feet).

The habitat is cornfields, fields and waste places, gardens, and sandhills by the sea. It occurs in the sand dune formation. I have found it on shingle on the foreshore, along with other inland weeds. It also occurs on chalk in chalk grassland.

The habit is trailing or creeping. The stem is four-angled, with water furrows, erect occasionally, or prostrate, then ascending, the plant being smooth and dotted with black dots or glands, much branched. The leaves are opposite, rarely in whorls of three to four, entire, ovate to oblong, occasionally heart-shaped, acute, stalkless.

The flowers are scarlet with purple claws, in the axils, on slender stalks in flower, curved downwards in fruit, longer than the leaves. The sepals are narrow, with a long point. The corolla is wheel-shaped, five-cleft like the calyx. There are five stamens. The fruit is a capsule or pyxidium, which

splits transversely along the middle. The seeds are three-angled.

The flowers are in bloom in June and July. The plant is a herbaceous annual, 6 in. or more in height.

The anthers and stigma ripen at the same time. There is no honey secreted. On the closing of the corolla the stamens and pistil come in contact. The corolla drops very soon, and in doing so the stigma is dusted with pollen. There is but one insect visitor, a bee (*ante*).

The fruit opens across the middle, the cells along this region being long and narrow, and they are not so closely attached as above and below.

Being so common a wild flower it is not unnatural that the plant has numerous names, especially as it is one of the weather plants, and it is called Bird's Eye, Bird's-tongue, Shepherd's Clock, John-go-to-bed-at-noon, Male Pimpernel, Merecrop, Orange Lily Pernel, Pimpernel, Poor Man's Weather-glass, Shepherd's Calender, Shepherd's Delight, Shepherd's Glass, Shepherd's Sundial, Shepherd's Warning, Shepherd's Watch, Shepherd's Weatherglass, Sunflower, Tom pimpernowl, Waywort, Weather Glass, Wincopipe, Wink-a-Peep.

This popular plant was reputed to prevent witchcraft. When the plant was gathered this charm was repeated:

> "Herbe Pimpernell, I have thee found,
> Growing upon Christ Jesus' ground;
> The same guilt the Lord Jesus gave unto thee

When He shed His Blood on the tree.
Arise up, Pimpernell, and goe with me,
And God blesse me,
And all that shall were thee. Amen."

It was to be said twice a day for fifteen days in succession, fasting in the morning, and in the evening with a full stomach; no one can predict how much good will follow.

ANAGALLIS ARVENSIS.—*In Fig.* 74 *the angled stem, the opposite, deeply-veined leaves, and the long-stalked flowers, some closed, and others in fruit, with the narrow calyx-lobes are figured.*

WATER VIOLET (*Hottonia palustris*).

Water Violet is an admirable example of an aquatic plant with floating or submerged leaves, which are much dissected, and arranged in a rosette, the whole plant being anchored in the mud by long rooting organs, which serve only as a means of attachment. The aërial flowering stems appear to indicate that the plant has migrated from the land to the water, having been originally perhaps riparial.

It is found in England and Ireland, in the last in Co. Down. It appears to be less general in the West of England, being a lowland plant confined to aquatic habitats, in the Midlands and East of England, though here and there it is found as far north as the borderland.

The Author. FIG. 74.—SCARLET PIMPERNEL (*Anagallis arvensis*). *See page* 329.

B. Hanley. FIG. 75.—WATER VIOLET (*Hottonia palustris*). *See page* 332.

The habitat is ponds, pools, channels, marshes, ditches. It is found in the reed swamp near the margin. Here it is associated with sedges and rushes, etc.

The plant is aquatic and has the rosette habit, with radical tufts of leaves. The whole plant is smooth and yellowish-green. The inflorescence, however, is glandular. The rootstock is creeping, the branches succulent, radiating from the scape, leafy and whorled, submerged, floating, and rooting. The joints are not swollen. The leaves are alternate, deeply divided nearly to the base, with slender segments narrow to linear, acute, pectinate.

The flowering stem arises from the middle of a whorl of branches, and is long, erect, cylindrical, leafless, with distant whorls of three to five flowers, on stalks bent down in fruit, with linear bracts. The flowers are lilac, or pale pink, with a yellow base. The calyx-lobes are linear, the calyx being five-cleft. The corolla has a straight tube with blunt lobes, shorter than the calyx, or very little longer, with a broad five-lobed limb. The style projects, the stamens are inserted on the tube, and the anthers and their stalks are nearly equal. In other cases the style is shorter and the stamens are inserted at the top of the tube, and the anther-stalks are three or four times as long as the anthers.

The capsule is five-valved, and contains many angled seeds, with the hilum at the base.

The flowers are in bloom between May and July.

The plant is a herbaceous perennial. Few aquatic plants are annual. The plant varies in height from 1 to 2 ft.

Honey is secreted at the base of the flower. The inflorescence is conspicuous, so that Flies and Hymenoptera visit the flowers.

There are two forms of flower as in the allied Primrose. These have been described above. The tube in each is 4 to 5 mm. long. The pollen-grains of the long-styled form are spherules ·011 to ·014 mm. in diameter, those in the short-styled form are ·018 to ·023 mm. in diameter, and in the latter case the style is 4 to 5 mm. long, in the former 7 to 9 mm. In legitimate pollination the larger pollen-grains are deposited on the stigma of the long-styled form, in which the stigma is rough and velvety, and has larger papillæ than in the short-styled form, which has a smooth stigma.

In legitimate pollination the stamens and stigma of equal height in the tubes are touched by insects in search of honey. Pollen seekers only dip their heads as far as the stamens in the short-styled forms, and if they visit many of this type may bring about illegitimate pollination; and in visiting several long-styled forms may bring about illegitimate crossing in that case also. The long-styled forms are more productive in the case of illegitimate crossings than the short-styled, the former not so often occurring.

In some cases the flowers are cleistogamic, and in the case of the short-styled form self-pollination

would result, but not in the long-styled form unless the stigma is bent over when the flowers are closed.

The fruit opens by five valves, and the seeds are dispersed by the wind and then by water and wind.

Water Violet is also called Bog Featherfoil, Featherfoil, Water Gilliflower, Water Milfoil, Water Violet, Water Yarrow.

As with some other plants, such as Frogbit, *hibernacula* or winter buds are produced, which is a mode of vegetative propagation, that enables the plant to continue its existence during the winter, whereas other plants die down.

HOTTONIA PALUSTRIS.—*In Fig.* 75 *the habitat of Water Violet is well shown, and the pectinate leaves, with the distant whorls of flowers* (*three to five in each*).

BROOKWEED (SAMOLUS VALERANDI).

This plant is cosmopolitan in its distribution. Pliny, who has already been mentioned as the author of other generic names, says: "The Druids have given the name of *Samolus* to a certain plant which grows in humid localities. This they say must be gathered fasting with the left hand, as a preservative against the maladies to which swine and cattle are subject." But it is not probable that it was at first applied to Brookweed. The second Latin name refers to some reputed use for which the plant was employed.

In autumn the plant dies down, and in summer

young shoots are formed which take root, and replace the original plant.

Brookweed is found throughout the British Isles, and in the Channel Islands. It seems, however, to be more frequent on the west coast.

As the English name implies, this plant is found by the margins of brooks, in wet ground and ditches, inland as well as by the sea, where perhaps it is most native, in sandy places and salt-marshes.

The habit is more or less the rosette habit, but the stems bear leaves. The whole plant is smooth, bright green, and shining. There is but a short root-stock. The stem is erect with prostrate or ascending branches, sometimes rooting. The leaves are inversely ovate or spoon-shaped, blunt, with a short point, entire. The radical leaves form a rosette, but the stem-leaves are alternate.

The flowers are white and small, in erect, loose, racemes. The flower-stalks are fairly long, with a green bract just above the middle, adnate to the axes like small bracteoles, the bract and axes elongating together, small and lance-shaped. The tube of the calyx is hemispherical, the lobes triangular, acute. The calyx adheres to the ovary. The corolla is crowned with a short tube, five lobes spreading, and a scale between each, alternating with the stamens. The capsule is round and small, crowned by the short teeth of the calyx, opening by five valves. The ovary is inferior, being sunk in the receptacular tube.

The flowers open between June and September.

FIG. 76.—BROOKWEED (*Samolus Valerandi*).

Messrs. Flatters and Garnett. *See page* 335.

The plant is a herbaceous perennial sometimes a foot in height.

There is a ring at the base of the ovary which secretes honey. There are five stamens on the petals, alternating with five rudimentary stamens or staminodes which are opposite the petals, the outer whorl being totally suppressed. The anthers and stigmas are of the same height, and the anthers open inwards so that self-pollination is possible. The style is short, the stigma blunt or pin-headed, and the stamens seated on the petals are included, with very short stalks.

The capsule opens by five valves and contains many seeds, which are dispersed by the wind.

Brookweed is also called Round Pimpinell, Water Pimpinell.

SAMOLUS VALERANDI.—*Fig.* 76 *shows the nearly rosette-like habit and the short rootstock, also the spathulate leaves, the loose, erect racemes, with long flower-stalks, and green bracts just above the middle.*

END OF VOL. II

APPENDIX

Since only a summary of the main features of plant life, as described in the Introduction, has been attempted, the reader who wishes to go deeper into the subject may with advantage study any of the works in the following list, in addition to those mentioned in the introductory volume (pp. 223–4). Reference has been made to a number of these works in the preparation of this book. Fuller lists will be found in some of these works for those who wish to make a close study of the subject :

On Buds and Stipules.—Lord Avebury.

On Seedlings.—Lord Avebury.

Plant Breeding.—L. H. Bailey.

British Plants : their Biology and Ecology.—J. F. Bevan and H. J. Jeffreys.

Dictionary of English Plant Names.—J. Britten, F.L.S., and R. Holland.

Plant Life and Evolution.—Prof. D. H. Campbell.

The Origin of Cultivated Plants.—A. De Candolle.

The Chemical Phenomena of Life.—F. Czapek.

Climbing Plants.—Charles Darwin.

Insectivorous Plants.—Charles Darwin.

Vegetable Mould and Earthworms.—Charles Darwin.

Plant Life.—Prof. J. B. Farmer.

Flowers and Flower Lore.—The Rev. H. Friend.

The Living Plant.—W. F. Ganong.

Structural Botany.—Asa Gray.

The Soil.—A. D. Hall.

Floral Structure.—Prof. G. Henslow.
Origin of Plant Structures.—Prof. G. Henslow.
The Soil.—F. H. King.
Agricultural Geology.—J. E. Marr.
Diseases of Cultivated Plants and Trees.—G. Massee.
Treatise on Rocks, Rock Weathering, and Soils.—G. P. Merrill.
The Cambridge Flora (vol. ii).—C. E. Moss.
Agricultural Botany.—J. Percival.
Mendelism.—R. C. Punnett.
The Classification of Flowering Plants: Vol. I.—A. B. Rendle.
Soil Fertility.—E. J. Russell.
Lessons on Soil.—E. J. Russell.
Soil Conditions and Plant Growth.—E. J. Russell.
Plant Geography.—A. F. W. Schimper.
Structural Botany.—Prof. D. H. Scott.
The Evolution of Plants.—Prof. D. H. Scott.
Agriculture.—W. Somerville.
The Anatomy of Plants.—W. L. Stevens.
Types of British Vegetation.—A. G. Tansley.
The Life of the Plant.—C. A. Timiriazeff.
Physiology of Plants.—Prof. S. H. Vines.
Plant Breeding.—H. De Vries.
Physical Properties of Soil.—R. Warington.
The Chemistry of the Farm.—R. Warington.
Œcology of Plants.—E. Warming.
The Cell.—E. B. Wilson.
The Geology of Soils and Substrata.—H. B. Woodward.

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